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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 19720, 19734, 19735, 20015, 20029, 20210, and 21716.

19532 (CEA-R-3051) L'ANALYSE SPECTROCHIMIQUE DES IMPURETES DANS LE PLUTONIUM ET SES COMPOSES. (Spectrochemical Analysis of Impurities in Plutonium and its Compounds). Buffereau, Michel; Crehange, Gerard; Deniaud, Suzanne; Leclainche, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1967. 134p. (In French). Dep. mn.

After a review of previous works, various powdered or wet analytical methods are discussed. A detailed know-how of studied methods is given, and validity of results is discussed. The problem of impurities in alloy analyses and non-spectroscopic determination of elements is reviewed. (88 references). (P.C.H.)

19533 (CEA-R-3155) LE DOSAGE RAPIDE DU CARBONE TOTAL DANS LES ALLIAGES URANIUM-CARBONE. (The Rapid Determination of Carbon in the Uranium-Carbon Alloys). Vigule, Jean-Claude; Spitz, Jean (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb. 1967. 16p. (In French). Dep. mn.

The determination of carbon in UC by a thermal conductivity method was studied by means of statistical analysis. In routine analysis the various factors influencing the uncertainty of the results are explained. A criterion of the sample homogeneity is proposed. (auth)

19534 (EUR-3279.f) ETUDE SUR LE DOSAGE COMPLEXOMETRIQUE DU MANGANESE DANS LES ALLIAGES ALUMINIUM-MANGANESE. (Study on the Complexometric Determination of Manganese in Aluminum-Manganese Alloys). Brueck, A. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Feb. 1967. 8p. (In French). Dep. mn.

The complexometric determination of manganese has been studied in the presence of aluminum. Erio T was used as an indicator and aluminum was masked with triethanolamine. The precision of the determination is greatly dependent on the presence of aluminum. (auth)

19535 (K-L-6140) ANALYTICAL PROCEDURES FOR URANIUM SPECIFICATIONS. Barton, J. C.; Weber, C. W.; Smith, L. A. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Apr. 6, 1967. Contract W-7405-eng-26. 190p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Analytical procedures used for the systematic specification analysis of various uranium compounds which are returned to the USAEC through the Oak Ridge Gaseous Diffusion Plant are compiled. The compounds normally encountered are UF_6, UF_4, UO_2, UO_3, U_3O_8, and $UO_2(NO_3)_2$. Accepted laboratory practices and standard equipment operations are omitted for brevity. The method for listing procedures is described, and an index for location of particular operation or specification analysis is included. (P.C.H.)

19536 (KFK-503) ACIDIMETRISCHE BESTIMMUNG DER FREIEN SAEURE UND DES URANS IN SALPETERSAUREN LOESUNGEN IN GEGENWART VON PLUTONIUM IV. (Acidimetric Determination of the Free Acid and the Uranium in Nitric Acid Solutions in the Presence of Plutonium(IV)). Thiele, D.; Baehr, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Nov. 1966. 9p. (In German). Dep. mn.

Free acid and U(VI) were determined acidimetrically in the presence of high Pu(IV) concentration in nitric acid after the Pu(IV) was separated with iodic acid as $Pu(IO_3)_4$. The method is applicable in the same way both for aqueous and organic solutions of Pu(IV), U(VI), and H^+. (tr-auth)

19537 (MG/D-329/65) FAST-NEUTRON REACTIONS AND THEIR POSSIBLE APPLICATION TO THE ACTIVATION ANALYSIS OF STEELWORKS MATERIAL. Scholes, P. H. (British Iron and Steel Research Association, Sheffield (England)). Nov. 1965. 16p. Dep. mn.

Supersedes MG/D-369/64.

The use of fast neutron generators in conjunction with gamma spectrometers for the direct analysis of steelworks material without the need for chemical separations is discussed. Available fast neutron reactions are listed for elements present in iron, steel, slags and iron ores. Principal interference effects are noted and possible applications discussed. (UKAEA)

19538 (N-67-12798) INFRARED SPECTRA OF VARIOUS METAL OXIDES IN THE REGION OF 2 TO 26 MICRONS. Sheibley, Dean W.; Fowler, Maurice H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec. 1966. 62p. (NASA-TN-D-3750). CFSTI $3.00 cy, $0.65 mn.

The infrared spectra of 52 metal oxides were determined through the sodium chloride and potassium bromide absorption regions. These spectra include the stable rare earth oxides and are the first comprehensive collection of infrared metal oxide spectra known to be published. (auth)

19539 (Y-KG-38) ATOMIC ABSORPTION ANALYSIS OF INDUSTRIAL WATER FOR METALLIC IMPURITIES. Dill, M. S. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 17, 1967. Contract W-7405-eng-26. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An atomic absorption spectrophotometric method is described for determining Fe, Cu, Cr, Zn, Ca, and Mg in industrial water. The industrial water samples are those from cooling towers, boilers, steam condensate, filtered and unfiltered supply, deaerators, and waste water discharged into streams. The method takes approximately one minute per sample and is free from spectral and chemical interferences in samples of this type. Ca and Mg were determined as carbonates. (P.C.H.)

19540 POSSIBILITY OF USE OF PHOTONEUTRON METHOD FOR DETERMINATION OF HYDROGEN IN METALS. Mazyukevich, N. P.; Shkoda-Ul'yanov, V. A. At. Energ. (USSR), 21: 388-9(Nov. 1966). (In Russian).

The photoneutrons from hydrogen and beryllium, present in lead in quantities of 10^{-4}%, were calculated in the energy interval from the (γ,n) threshold reaction at E = 6.71 Mev. Tabulated results showed that if the admixture of beryllium is 2 to 3 times less than that of hydrogen, then hydrogen can be determined by the photoneutron method. As literature data show Be is present in U in quantities of 10^{-6}%, 10^{-3} to 10^{-4}% H_2 can be determined in U by this method. The photoneutron registration necessary for statistical precision in lead containing 10^{-4}% H_2 and 10^{-6}% Be is 5%. (J.S.R.)

19541 DETERMINATION OF FLUORITE BY ACTIVATION ANALYSIS IN ORE SAMPLES AND CONCENTRATION PRODUCTS. Prokopchik, V. I.; Subbotina, T. I. At. Energ. (USSR), 21: 415-17(Nov. 1966). (In Russian).

A field apparatus for the activation determination of fluorite in

ore samples and concentrates was described. Comparison with chemical analysis shows that activation determination of fluorite is less precise than chemical determination, but speed of the activation method is much greater. (J.S.R.)

19542 APPLICATION OF ARSENAZO III AND OTHER AZO COMPOUNDS IN THE PHOTOMETRIC DETERMINATION OF CERTAIN ELEMENTS. Alimarin, I. P.; Savvin, S. B. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Pure Appl. Chem., 13: 445-56(1966).

Analytical effects of Arsenazo III and other azo compounds on the rare earths and many other elements are reviewed in detail including the mechanism of complex formation and the nature of the color reactions. (P.C.S.)

19543 ANALYTICAL STUDY OF THE BASIC PROPERTIES OF LEAD TETRAACETATE AS OXIDIZING AGENT. Zyka, J. (Charles Univ., Prague). Pure Appl. Chem., 13: 569-82(1966).

Polarographic studies of lead tetraacetate in HCl, H_2SO_4, H_3PO_4, and $HClO_4$ were undertaken. Satisfactory results were obtained with HCl and $HClO_4$ with negative results from the other acids. A review of the wide analytical applications of lead tetraacetate as volumetric reagent for the determination of inorganic and organic substances, including uranium, is given. (P.C.S.)

19544 APPLICATION OF HOLLOW-CATHODE DISCHARGE TUBE FOR SPECTRAL-ISOTOPIC DETERMINATION OF GASES IN METALS. Zakorina, N. A.; Lazeeva, G. S.; Petrov, A. A. Vestn. Leningr. Univ., No. 22, Ser. Fiz. Khim., No. 4, 38-40(1966). (In Russian).

An application of a hollow-cathode discharge tube for spectral-isotopic determination of oxygen in metals is described. The analyses were performed with the CO^+ molecule spectrum. The method was tested on the iron–cobalt alloy samples. (auth)

19545 COMPLEXATION OF ALUMINIUM, YTTRIUM, LANTHANUM AND LANTHANIDES WITH 4-(2-PYRIDYLAZO)-RESORCINOL (PAR). Sommer, L.; Novotna, H. (Purkyne-Univ., Brno). Talanta, 14: 457-71(Apr. 1967).

The sensitive reactions between 4-(2-pyridylazo)resorcinol (PAR) and yttrium, lanthanum, and the lanthanides can be used for the spectrophotometric determination of these elements. The method has no advantage over other methods for the determination of aluminium and lanthanum. Only M(PAR)H and M(PAR) complexes are formed in solutions where the molarity of the metal ion is greater than or nearly equal to the molarity of the ligand at pH < 7·5. If there is molar excess of PAR, 1:2 complexes may be formed, but this is certain only for the yttrium–PAR system. Errors in analysis may result from the simultaneous occurrence of optically different complexes; close control of pH and reagent concentration is essential. Optical and equilibrium data are given for the systems investigated. (auth)

19546 URANYL ACETATE AS SPRAY REAGENT IN THIN-LAYER CHROMATOGRAPHY. Scherz, H.; Weisz, H. (Univ., Freiburg i. B.). Mikrochim. Acta, No. 2, 307-9(1967). (In German).

If a 1% aqueous solution of uranyl acetate is sprayed on a plate carrying a layer of silica gel and then dried, there results a yellow–green fluorescence in uv (254 nm) that is quenched by numerous materials. This finding can be employed for the detection of the most varied substances after they have been separated by thin layer chromatographic procedures. Examples of the sensitivity limits are given. (auth)

19547 THE APPLICATION OF NEUTRON ACTIVATION FOR DETERMINATION OF ELEMENTS IN ALUMINUM, MAGNESIUM, BERYLLIUM, AND THEIR ALLOYS. Rakovic, Miloslav (Charles Univ., Prague). Jad. Energ., 12: 458-60(Dec. 1966). (In Czech).

A brief review is given on neutron activation analyses for determining impurities in Fe and its alloys and Al, Mg, and Be and their alloys. (R.V.J.)

19548 NEUTRON ACTIVATION ANALYSIS OF MAGNESIUM, CALCIUM, STRONTIUM, BARIUM, MANGANESE, COBALT, COPPER, ZINC, SODIUM, AND POTASSIUM IN HUMAN ERYTHROCYTES AND PLASMA. Olehy, D. A.; Schmitt, R. A.; Bethard, W. F. (Dept. of Navy, San Diego, Calif.). J. Nucl. Med., 7: 917-27(Dec. 1966).

A method is described for quantitation of Mg, Ca, Sr, Ba, Mn, Co, Cu, Zn, Na, and K in human erythrocytes and plasma by thermal neutron activation and rapid ion exchange radiochemical separation. Representative values are presented and compared with previously published ranges, where available in the literature. Limits of error inherent in the method are given. (auth)

19549 THE CHEMICAL CLASSIFICATION OF IRON METEORITES. I. A STUDY OF IRON METEORITES WITH LOW CONCENTRATIONS OF GALLIUM AND GERMANIUM. Wasson, J. T. (Univ. of California, Los Angeles). Geochim. Cosmochim. Acta, 31: 161-80(Feb. 1967).

The concentrations of Ga and Ge were determined in 34 iron meteorites by neutron activation analysis. These samples contained concentrations below the detection limits of techniques employed by previous investigators. The classification of these meteorites is discussed. Certain regularities were observed in plots of Ge/Ga concentration and Ge/Ni concentration. These are discussed in terms of the multiple parent-body hypothesis and also in terms of planetary fractionation processes. (UK)

19550 DETERMINATION OF IRON BY CHELATING RADIOMETRIC TITRATION. Konecny, J.; Toelgyessy, J.; Braun, T. (Slovak Technical Univ., Bratislava. Eoetvoes Univ., Budapest). Acta Chim. Acad. Sci. Hung., 51: 245-9(1967).

In an investigation of a chelating radiometric titration, 5×10^{-3} M EDTA solution, Dowex 50 W–X2 cation exchanger, and $^{55+59}Fe$ radionuclide were used as the titrant, for the separation of components, and as the indicator, respectively. Iron in pharmaceutical products (Tinctura Ferri aromatica) was determined. The method can also be used to determine amounts of submicro grams of iron. (auth)

19551 ELECTROGRAPHIC DETERMINATION OF MAGNESIUM IN MAGNESIUM ALLOYS AND OF ZIRCONIUM IN ZIRCONIUM ALLOYS. Shiobara, Yai (Tokyo Kyoiku Univ.). Trans. Jap. Inst. Metals, 7: 292-5(Oct. 1966).

A rapid electrographic determination of magnesium in magnesium–aluminum or magnesium–nickel alloys and zirconium in zirconium–nickel alloys was developed. The method consisted of the stripping of alloy constituents into a filter paper moistened with a supporting electrolyte solution and the subsequent measuring of the intensity of color developed on the paper spectrophotometrically. Suggested electrolyte solutions were 0.5 M sodium potassium tartrate for magnesium alloys and 0.5 M NH_4Cl for zirconium alloys. After electrographic stripping (4 V, 10 mA, 10 sec for magnesium and 20 sec for zirconium) of the alloy constituents into the filter paper under a pressure of 2 kg per 6.25 cm^2, the filter paper was treated with a saturated ethyl alcohol solution of quinalizarin for magnesium and with an ethyl alcoholic solution of 0.5% alizarin for zirconium to develop the colored pattern to be measured at 560 and 510 mμ, respectively. The method seems to be of special value for a rapid and practically nondestructive determination of magnesium and zirconium in their alloys. (auth)

19552 PROTEIN-BOUND IODINE DETERMINATION BY ACTIVATION ANALYSIS. Feldman, Milton H.; McNamara, James; Reba, Richard C.; Webster, William. J. Nucl. Med., 8: 123-31 (Feb. 1967).

A rapid simple method using anion-exchange resin column technique combined with radioactivation analysis is described for the determination of serum protein-bound iodine concentration. Determinations made on patients' serum were consistently close to results obtained by the usual dry ash method. The basic simplicity of the method and the rapidity with which it can be done were of primary consideration. (auth)

19553 EXTRACTION-PHOTOMETRIC DETERMINATION OF PLUTONIUM(IV) BY MEANS OF ARSENAZO III. Milyukova, M. S.; Savvin, S. B. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 22: 353-8 (Mar. 1967). (In Russian).

Extraction of plutonium as a complex with Arsenazo(III) from nitric, hydrochloric, and sulfuric acid solutions was studied. It was established that the plutonium complex with Arsenazo(III) can be quantitatively extracted from 0.1 to 1M solutions of nitric acid by butyl alcohol containing tribenzylamine. The extraction of plutonium from hydrochloric and sulfuric acid solutions is less complete. An extraction-photometric method for determining plutonium by means of Arsenazo(III) is suggested including the complex extraction from 0.1M HNO_3 (one time extraction) or 1M HNO_3 (two times extraction) by butyl alcohol, then the extract is diluted with 8M HNO_3 (treated with urea) and the optical density is measured at 680 nm. The method permits the determination of down to 0.1 μg of plutonium in the presence of milligram amounts of Ag^+, Cu^{2+}, Ni^{2+}, Pb^{2+}, Al^{3+}, and La^{3+}. Chromium, iron(III), and uranium interfere in the determination. (auth)

19554 PHOTOCHEMICAL REACTIONS IN ANALYTICAL CHEMISTRY. COMMUNICATION 2. REDUCTION OF URANIUM(VI) TO URANIUM(IV) WITH ETHANOL IN PHOSPHORIC ACID SOLUTIONS. Nemodruk, A. A.; Bezrogova, E. V. Zh. Anal. Khim., 22: 366-70(Mar. 1967). (In Russian).

A study was made of the photochemical reduction of uranium(VI) to uranium(IV) with ethanol in phosphoric acid solutions. A method was developed for the determination of uranium by its photochemical reduction to uranium(IV) in a phosphoric acid medium followed

by the titration of the uranium(IV) formed with a solution of ammonium vanadate in the presence of sodium diphenylamine sulfonate. The mean-square error on the determination of 1 to 40 mg of uranium is ±0.64%. One determination takes not more than 15 min. (auth)

19555 NEUTRON ACTIVATION ANALYSIS AND ITS APPLICATION TO MEDICAL RESEARCH. Chupeev, N. E.; Dukenbaeva, A. B. (Central Inst. for the Professional Development of Physicians, Moscow). Gig. Sanit., 32: 76-81(Jan. 1967). (In Russian).

The very sensitive and relatively simple neutron activation method makes it possible to determine microelements in biological systems within the concentration range from 10^{-6} to 10^{-10}%. The method is based on the following nuclear transformations: a simple (n,γ) capture; radiative capture with subsequent β decay of the intermediate, short-lived isotope; and transformation of the radioactive isotope of the neighboring element and radiative capture with emission of a heavy particle. The time needed for reaching maximum activity in the sample depends on the half-life of the element. The container material used must be free from impurities with high capture cross section. The actual analysis is carried out on solutions by means of the usual radiochemical methods, using G-M or scintillation counters for activity measurements. The method is well suited for the study of food since the presence of minute traces of foreign matter, such as insecticides, may be easily demonstrated. It is also widely used in criminology, e.g., to determine the concentration of certain elements in human hair and to show the presence of Hg, Cu, Mn, Zn, Cr, Sb, Sc, or Co in drugs and antibiotic preparations. Elements with a low atomic number and low thermal neutron capture cross section, such as O, Fe, Na, Br, etc, should be activated with 14-MeV fast neutrons or by other heavy particles. (TTT)

19556 ACTIVATION ANALYSIS AS A TOOL FOR MEDICAL RESEARCH. Comar, Dominique (Commissariat a l'Energie Atomique, Orsay, France). Nucleonics, 24: No. 11, 54-7(Nov. 1966).

Use of activation analysis for studying trace-element metabolism in biomedicine is considered. Biomedical problems measuring iodine, mercury determination, and vanadium studies are described. (M.C.G.)

19557 NEUTRON ACTIVATION ANALYSIS OF BLOOD AND BLOOD SERUM FOR COPPER AND ZINC. Thomas, C. C. Jr.; Tercho, G. P.; Sondel, J. A. (Western New York Nuclear Research Center, Buffalo). Nucl. Appl., 3: 53-7(Jan. 1967).

A procedure for the analysis of copper and zinc in blood and blood serum is described. Radiochemical techniques are used for the elimination of interference such as 24 Na. Both Cu and Zn are recovered from a single sample. Analysis time for a single sample duplicated is of the order of two hours. Sixteen samples in duplicate can be processed in approximately 12 hr. Mean serum values for normal individuals were found to be 1.54 and 1.20 ppM for copper and zinc, respectively. Mean copper and zinc whole blood values for normal individuals were found to be 1.25 and 8.13 ppM, respectively. (auth)

19558 NEUTRON-ACTIVATION ANALYSIS. Wahl, Werner H.; Kramer, Henry H. Sci. Amer., 216: No. 4, 68-72; 78-80; 82(Apr. 1967).

Uses of neutron activation analysis for measuring concentrations of trace elements are discussed and the principles of the technique summarized. The procedure followed in performing a typical analysis is described. Sensitivity of the method is considered. (M.C.G.)

19559 APPARATUS FOR AUTOMATIC EXTRACTIVE RADIOMETRIC TITRATION. Kukula, F. Isotopenpraxis, 3: 17-19(Jan. 1967). (In Russian).

The apparatus described for continual extractive radiometric titration enables automatic time- and volume-controlled dosage of complexing reagents into the analyzed solution and its stirring. The activity of either the organic or inorganic layer can be measured and recorded by means of a pen recorder. The apparatus can also be used for studying extraction processes and their kinetics, for complexometric and similar studies, when the appropriate device (pH meter, recording colorimeter etc.) is attached. The use of this apparatus for isotopic dilution analysis and for studying substoichiometric methods of separation of some elements in activation analysis serves as an example of its application. (auth)

19560 THE X-RAY FLUORESCENT ANALYSIS OF ALLOYS OF Mn WITH Dy, Ho, AND Er. Kirchmayr, Hans Rudolf (Technische Hochschule, Vienna). Acta Phys. Austr., 24: 234-44 (1966). (In German).

The quantitative analysis of alloy powders of the rare earths Dy, Ho, and Er with Mn by means of x-ray fluorescence can be carried out with very small samples when the matrix effect is eliminated. This is done by dissolution of 0.001 to 0.2 g of the alloy in 5 to 10 ml dilute nitric acid. A very rigorous calibration curve was obtained for 0 to 100% Mn, Dy, Ho, and Er. If both the counting statistics and the background radiation are considered, an accuracy of ±0.5% and a detection limit of approximately 2×10^{-2} wt % are obtainable. The measured and the calculated dependence of the intensity of HoL_{α} or MnK_{α} on the concentration and composition of the solution agree. (tr-auth)

19561 COMPARISON OF THE RADIOISOTOPE DILUTION-COATED CHARCOAL METHOD AND A MICROBIOLOGICAL METHOD (L. LEICHMANNII) FOR MEASURING VITAMIN B_{12} IN SERUM. Raven, J. L.; Walker, P. L.; Barkhan, P. (Guy's Hospital, London). J. Clin. Pathol., 19: 610-13(Nov. 1966).

A comparison was made of the radioisotope dilution-coated charcoal method and a microbiological assay (with Lactobacillus leichmannii as test organism) for determining the concentration of vitamin B_{12} in serum. A satisfactory correlation was found between the results of the 2 methods. Under appropriate conditions the reproducibility of the radioisotope method compared favorably with that of the microbiological method. In the radioisotope method unlabeled vitamin B_{12} is released from serum and dilutes the sp act. of a known quantity of added ^{57}Co-labeled vitamin B_{12}. A representative sample of the mixture of unlabeled and radioactive B_{12} is then bound to intrinsic factor which, having a B_{12}-binding capacity less than the amount of added ^{57}Co-B_{12}, becomes saturated with the B_{12} mixture. Unbound B_{12} is removed by absorption onto protein-coated charcoal. The degree of dilution of the radioactive B_{12} in the mixture will be reflected in the relative amounts bound to intrinsic factor. The concentration of B_{12} in the serum can be calculated by comparing the quantity of radioactive B_{12} bound to intrinsic factor in the presence of the test serum with that in a control containing only intrinsic factor and an identical amount of ^{57}Co-B_{12}. Results can be obtained in hours with the radioisotope method compared with at least 3 days for microbiological methods. A potential advantage of the radioisotope method is that it lends itself more easily to automation. (BBB)

19562 EXPERIMENTAL SENSITIVITIES IN NEUTRON ACTIVATION AND GAMMA SPECTROMETRY WITH A 150-kV ACCELERATOR. Perdijon, Jean. Anal. Chem., 39: 448-56(Apr. 1967).

The possibilities offered in neutron activation analysis using a 150-kV accelerator are reported. A catalog of gamma spectra given by main elements under defined irradiation and counting conditions was established. The photoelectric peaks recognized on these spectra were listed in increasing order of energy so as to facilitate qualitative analysis. The potential limit of detection achievable with each photopeak was calculated, and optimum limits of detection for the elements under study were deduced. (auth)

19563 DETECTION LIMITS OF ELEMENTS IN THE SPECTRA OF PREMIXED, OXY-ACETYLENE FLAMES. Fassel, Velmer A.; Golightly, Danold W. (Iowa State Univ., Ames). Anal. Chem., 39: 466-76(Apr. 1967). (IS-1441).

Detection limits are reported for 67 elements in the spectra emitted in the various zones of premixed, oxy-acetylene flames. The observed values are compared with those obtained by flame atomic absorption and by direct, high-voltage, spark excitation of solutions. Generalizations are drawn on the effect of excitation potentials, monoxide stabilities, and other physical properties on detection limits. Forty-three elements are detectable in this flame at concentrations of 1 μg/ml or less. These observations portend an increasing use of flame emission techniques for the determination of trace elements in solution. (auth)

19564 INTERNAL STANDARD TECHNIQUES FOR DETERMINATION OF OXYGEN IN MAGNESIUM, STEEL, AND TITANIUM BY ACTIVATION ANALYSIS. Twitty, Bryce L.; Fritz, Kenneth M. (National Lead Co. of Ohio, Cincinnati). Anal. Chem., 39: 527-9(Apr. 1967).

The internal-standard method of activation analysis for determination of oxygen in magnesium, steel, and titanium was studied If a sample matrix is suitable for 14-MeV activation, its activation products can be used as an internal standard for both the flux and sample weight corrections; thus the preparation and calibration of standards are minimized since they are required only for determining changes within the instrument system. The principal problem in using the internal-standard technique is due to the flux-time spectra. When the two isotopes measured have different half lives, they are not equally affected when the flux varies during the exposure time. The relative precision found using the internal-standard technique for titanium was 3% at an average level of 0.132%, for steel was 5% at an average level of 60 ppM, and for magnesium was 4% at an average of 0.156%. While analyzing the steel samples for oxygen under the activation cycle, the activation products of Cr, Mn, and Si were seen and could be analyzed simultaneously. (D.H.M.)

19565 ESTIMATION OF MOLYBDENUM IN BIOLOGICAL MATERIAL BY NEUTRON ACTIVATION ANALYSIS. Livingston, H. D.; Smith, Hamilton (Glasgow Univ.). Anal. Chem., 39: 538-9(Apr. 1967).

Determination of molybdenum in biological materials using neutron activation analysis was accomplished by gamma detection of ^{99}Mo. By using favorable parent/daughter half lives of the nuclides in the ^{99}Mo/^{99m}Tc couple, it was found possible to devise a separation producing ^{99m}Tc in a radiochemically pure form. The second separation of newly equilibrated ^{99m}Tc under the same conditions as the first separation ensured that no radio-contaminant could be inadvertently separated and counted. Using this analytical scheme the molybdenum content in human teeth, dry human tissues, dry vegetable tissues, and dried, powdered kale was determined. The experimental limit for molybdenum detection at a thermal neutron flux of 10^{12} n/cm^2/sec was found to be 0.01 μg. For samples containing smaller amounts of molybdenum, analysis became possible when irradiation was carried out at a thermal neutron flux of 10^{14} n/cm^2/sec. Analyses made on standard amounts of molybdenum gave an average error between the actual and measured value of 3.5%. (D.H.M.)

19566 RAPID SONICATION TECHNIQUE FOR LIQUID SCINTILLATION COUNTING OF ^{14}C-LABELED BARIUM CARBONATE. Allred, John B. (Oklahoma City Univ.). Anal. Chem., 39: 547(Apr. 1967).

A method for the liquid scintillation counting of radioactive samples, which are insoluble in the counting solution, is reported, which utilizes sonic oscillation to rapidly reduce particle size. The technique decreased preparation time and settling rate and eliminated the need to agitate the sample between successive counts or correct for the settling rate. Carbon-14-labeled barium carbonate was weighed and counting solution, based upon a dioxane–naphthalene system, was added. Each sample was subjected to sonic oscillation for 20 to 30 sec and counted for 3 min three successive times without agitation between counts. The method gave reproducible results with high counting efficiency. (D.H.M.)

19567 RADIOGRAVIMETRIC DETERMINATION OF POTASSIUM. I. DETERMINATION OF POTASSIUM IN MINERALS. Rodziewicz, Wlodzimierz; Grzedzicki, Kazimierz (Politechnika, Danzig). Chem. Anal. (Warsaw), 12: 49-56(1967). (In Polish).

The determination of potassium using results from the gravimetric determination of quantitatively precipitated potassium–sodium cobaltinitrite and determination of the potassium content from the β radioactivity of a sample of the $Me_3[Co(NO_2)_6]$ precipitate (Me = K + Na) is described. The measurements of radioactivity were carried out with a G–M tube and the samples were prepared as "infinitely thick" or as 0.122 g/cm^2 thick. The potassium content in $Me_3[Co(NO_2)_6]$ was found from calibration curves set up for the layer thicknesses of 0.407 g/cm^2 and 0.122 g/cm^2. Absolute error of the results obtained by the radiogravimetric method was 0.02 to 0.2%. The results obtained show that sufficient accuracy can be achieved by preparation of samples thinner than the "infinitely thick." (auth)

19568 VOLUMETRIC DETERMINATION OF MIXTURES OF Ce(III) AND La(III) USING $K_4Fe(CN)_6$. Basinska, Halina; Soboczynska, Janina (Copernicus Univ., Torun, Poland. School of Agriculture, Olsztyn, Poland). Chem. Anal. (Warsaw), 12: 165-9(1967). (In Polish).

A method for volumetric determination of mixtures of Ce(III) and La(III) in solution was worked out. The method consisted of determining the total amount of Ce(III) and La(III) by titration with $K_4Fe(CN)_6$ in 25% ethanol medium in presence of 3,3'-dimethylnaphthidine as a redox indicator. The titration was carried out at pH 5 to 6; acetate buffer was used. At the equivalence point the color suddenly changed from dark pink to aquamarine. Ce(III) was then oxidized with $K_3Fe(CN)_6$ in an alkaline medium at 0°C. Ce(IV) and La(III) hydroxides were precipitated and to the solution passed an equivalent quantity of ferrocyanide, liberated from $KCeFe(CN)_6$ and $KLaFe(CN)_6$ deposits, and formed in the course of Ce(III) oxidation with $K_3Fe(CN)_6$. The solution was filtered and the ferrocyanide content of the hydroxide filtrate was determined by the manganometric method. The relative error was not greater than ±1.0% in comparison with the gravimetric method in the case of Ce and the potentiometric method in the case of La. The method can be applied for analyses of $CeCl_3$ and $LaCl_3$ present in solutions at concentrations from 0.05M to 0.2M. The sample volume should be from 10 to 20 ml. (auth)

19569 THE GLOBAL DISTRIBUTION OF IODINE, BROMINE, AND CHLORINE IN MARINE AEROSOLS. Winchester, John W.; Duce, Robert A. (Massachusetts Inst. of Tech., Cambridge). Naturwissenschaften, 54: 110-13(Mar. 1967).

Atmospheric samples were analyzed for iodine, bromine, and chlorine by neutron activation analysis. Aerosols of marine origin, derived from sea spray, were found to contain the halogens in relative proportions different from sea water, and data from Hawaii and winter northern Alaska indicate fractionation of the elements both during transfer across the sea-air interface and by chemical reactions in the atmosphere. The ratio Br/Cl is usually several-fold greater in aerosols over land than in sea water (Br/Cl = 0.0034), but over open sea water it is less. In general, the ratio I/Br exhibits a greater degree of constancy (values cluster in the region I/Br ~0.1 to 0.2) than does either I/Cl or Br/Cl, suggesting a long residence time and a coherence of I and Br in their movement as particulate material in the atmosphere. However, a singularly effective sea-air transfer mechanism for iodine is indicated by its generally high atmospheric concentration compared to sea water (I/Br = 0.001). Bromine of pollution origin and associated with lead was observed in aerosols from Cambridge, Massachusetts. Chlorine and iodine concentrations are similar to the Hawaii values and provide a basis for resolving excess pollution bromine from the natural marine component. The ratio (excess Br)/Pb in aerosols appears to be correlated directly with the haziness of the air. (auth)

19570 DETERMINATION OF TRACE AMOUNTS OF COBALT IN HAEMIN BY NEUTRON ACTIVATION ANALYSIS. Maxia, V.; Meloni, S.; Rollier, M. A.; Valentini, M. T. (Univ. of Pavia, Italy). Int. J. Appl. Radiat. Isotop., 18: 267-9(Apr. 1967).

A possible substitution of Fe by Co in the biological synthesis of haemoglobin was investigated. The determination by neutron activation analysis of haemin from bovine blood is described. The iron was separated, after irradiation, by ion exchange. Solvent extraction was known to give bad reproducibility, and Co losses up to 30%. Details are given of the experimental procedure. It was noted that Zn may interfere with the Fe–Co ion exchange separation, and that ^{65}Zn emits 1.12-MeV gamma rays, which overlap the 1.17-MeV gamma rays of ^{60}Co. Trace amounts of Zn may spread through the column and be eluted with Co. In order to avoid this, zinc chloride was added as carrier to the HCl solution. The ions were adsorbed on the column with 9M HCl, the Co eluted with 5M HCl, and the Fe with 0.5M HCl. Zn was eluted with 0.2M HCl. The Co was precipitated as cobaltinitrite for counting. Spectrophotometric analysis was employed to determine the chemical yields. The average amount of Co in the haemin was found to be 146 ± 5 ppB. Reproducibility was good. (UK)

19571 RAPID ASSAY OF HIGH PURITY GOLD BY MEANS OF RADIOISOTOPE X-RAY FLUORIMETRY. Snyman, G. C. (Atomic Energy Board, Pelindaba, South Africa). Int. J. Appl. Radiat. Isotop., 18: 243-6(Apr. 1967).

The use of ^{241}Am to analyse high-purity gold by excitation of characteristic silver x rays is described. The complete assay is effected in 5 min, and is accurate to 2 parts in 10,000 for 99.50% gold. (auth)

19572 NONDESTRUCTIVE DETERMINATION OF IMPURITIES IN RED PHOSPHORUS BY NEUTRON ACTIVATION AND GAMMA SPECTROMETRY. PART I. Patek, P.; Sorantin, H. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Z. Anal. Chem., 226: 338-46(Feb. 22, 1967). (In German).

In six samples of red phosphorus of different origin trace elements were determined by nondestructive neutron activation analysis. Only those nuclides which have a half life shorter than 15 hours were analyzed. Qualitatively 8 elements were detected; some of them were analyzed quantitatively, comparing their activity with simultaneously irradiated standards. Larger differences in the amount of trace elements in the different phosphorus samples could be observed. Sodium and aluminium were the most important contributors to the impurity level. (auth)

19573 SMALL SPECIMEN METHOD FOR DETERMINING THE MEAN HALF-LIFE OF THERMAL NEUTRONS. Miller, V. V. At. Energ. (USSR), 22: 33-8(Jan. 1967). (In Russian).

A method for the determination of the mean half life of thermal neutrons τ in samples, the dimensions of which are of the order of the transmission length of thermal neutrons, is described. The method is based on the utilization of neutron pulse generators and is intended for the determination of τ in rocks in measurements on core samples. It can also be used for the determination in rocks of elements with high absorption cross sections for thermal neutrons. (tr-auth))

19574 GRAVIMETRIC DETERMINATION OF URANIUM WITH m-AMINOBENZOIC ACID AND 1,10-PHENANTHROLINE. INDIRECT VOLUMETRIC DETERMINATION BY TITRATION OF THE AMINO ACID OF THE COMPLEX WITH SODIUM NITRITE. Ripan, Raluca; Sacelean, Viorel (Institut de Chimie de l'Academie, Cluj). Rev. Roum. Chim., 12: 17-20(Jan. 1967). (In French).

A method for the gravimetric determination of uranium, based

on the precipitation of UO_2^{2+} ions at a pH ~4 with an aqueous solution of m-aminobenzoic acid and 1,10-phenanthroline, is given. A crystalline precipitate, $UO_2(m-H_2N-C_6H_4-COO)_2 \cdot C_{12}H_8N_2$, was found, filtered, washed, dried in an oven, and then weighed. The indirect volumetric determination of the uranium is based on the decomposition of the complex mentioned with hydrochloric acid and the titration of the m-aminobenzoic acid with sodium nitrite. (tr-auth)

19575 PROBLEMS OF CHANGE IN NEUTRON FLUX IN A SAMPLE IN ACTIVATION ANALYSIS. Rakovic, Milosav; Prouza, Zdenek (Charles Univ., Prague). Chem. Listy, 60: 1496-1508(Nov. 1966). (In Czech).

The effects of self-absorption, hardening and moderation on the neutron flux in activation analysis were studied both experimentally and theoretically. Thirty-two references are reviewed, which show possible ways of evaluating or eliminating such errors. One method is to use an internal standard. Another is to use a calibration curve or to calculate the error from an equation. Such an equation is derived, in which terms appear for the ratio of the fraction of the total neutron flux in the sample to the total flux and the effective resonance integral. Standard nuclear constants are used for the calculation, i.e., cross sections from known tabulated values. (TTT)

19576 POLAROGRAPHIC DETERMINATION OF RARE EARTH IONS IN SOLUTIONS CONTAINING AMMONIUM LACTATE. Inczedy, Janos; Erdey, Laszlo (Polytechnical Univ., Budapest). Acta Chim. Acad. Sci. Hung., 51: 349-57(1967).

The complex replacement polarography of some rare earth ions in ammonium lactate solutions was investigated. Rare earth ions in ammoniacal solutions of pH 9 replaced the complexed metal ions nearly stoichiometrically, when Cu-EDTA or Zn-EDTA complex was used as the reagent. By means of the polarographic measurement of the released copper (or zinc) ion, the rare earth ions were estimated indirectly. (auth)

19577 DETERMINATION OF OPTIMUM SCHEDULE AND SENSITIVITY FOR NON-DESTRUCTIVE ACTIVATION ANALYSIS. Quittner, Pal; Montvai, Attila (Central Research Inst. for Physics, Budapest). Acta Chim. Acad. Sci. Hung., 51: 371-80(1967).

A method was developed for the calculation of optimum activation and subsequent cooling time before activation analysis in order to keep the relative error in the measured value of the activity in question at a minimum when the measurement is performed by scintillation spectrometer. Besides the background there is usually interfering activity present. The calculated values of relative accuracy and maximum possible sensitivity for various times of measurement are given. Results obtained from the calculations determine if there is any necessity for additional chemical separation. (J.G.B.)

19578 A COMPLEXOMETRIC METHOD FOR THE ESTIMATION OF THORIUM AND CHROMIUM FROM A MIXTURE. Verma, M. R.; Agrawal, K. C.; Amar, V. K. (National Physical Lab., New Delhi). Indian J. Chem., 5: No. 2, 79-80(1967).

Thorium and chromium were estimated in their binary mixtures using chenta acid as the complexing reagent. Cr, which forms a violet colored 1:1 complex in solution, was determined colorimetrically whereas Th, which forms a colorless 1:1 complex, was estimated volumetrically by titrating excess chenta acid against standard copper sulfate solution using calcein as the fluorescent indicator. The method is simple and may be of general applicability in the analysis of Th–Cr mixtures over a wide range of concentrations. (auth)

19579 DETERMINATION OF FLUORINE IN FLUORITE ORES AND CONCENTRATES BY ISOTOPE-SOURCE FAST-NEUTRON ACTIVATION ANALYSIS. Jeffery, P. G.; Bakes, J. M. (Ministry of Tech., Stevenage, Eng.). Analyst, 92: 151-5(Mar. 1967).

The fluorine contents of fluorite ores and concentrates were determined by activation analysis. No sample preparation, other than crushing and grinding, was required. Sources employed were Th–Be and Am–Be. (UK)

19580 ABUNDANCE OF MERCURY IN METEORITES AND ROCKS BY NEUTRON ACTIVATION ANALYSIS. Ehmann, William D.; Lovering, John F. (Australian National Univ., Canberra). Geochim. Cosmochim. Acta, 31: 357-76(Mar. 1967).

Mercury abundances were determined in all classes of chondritic meteorites, the principal classes of achondritic meteorites, alkali and tholeiitic basalts, differentiated tholeiitic basalt intrusions, possible lower crustal and upper mantle rock inclusions, and a collection of six standard crustal rocks using thermal neutron activation. Relatively high mercury abundances in the carbonaceous chondrites were confirmed. Abundance data among the various classes of chondrites and achondrites suggest a more complex behavior for mercury in the evolution of the meteorites than previously proposed. Possible lower crustal or upper mantle materials exhibited high mercury abundances in the range of the basic achondrites while the six standard crustal rocks had abundances in the range of only 0.004 to 0.04 ppM. Implications of the data with respect to the estimation of cosmic abundances, and the evolution of the meteorites and the earth are discussed. (auth)

19581 ANALYTICAL APPLICATIONS OF A 0.5-MeV COCKCROFT–WALTON SET BASED ON THE MEASUREMENT OF PROMPT γ RADIATION. GAMMA-RADIATION EMITTED DURING PROTON REACTIONS. Pierce, T. B.; Peck, P. F.; Cuff, D. R. A (Atomic Energy Research Establishment, Harwell, Eng.). Analyst, 92: 143-50(Mar. 1967)

Nuclear reactions are outlined, which yield γ rays when the elements from lithium to chlorine, with the exception of neon, are irradiated with protons of energy 0.5 MeV or less. Energies of the principal γ rays are listed and analytical applications based on measurements of the γ rays are discussed. (UK)

19582 CHEMICAL ANALYSIS. Arnfelt, A.-L.; Tyden, G.; Svensson, P.; Oesterlundh, C. G. (Aktiebolaget Atomenergi, Stockholm). Svensk Kem. Tidskr., 79: No. 2, 146-53(1967). (In Swedish).

A survey of analytical activities at the Swedish Atomic Energy Company is reported. The most common elements treated are the actinides, uranium, and plutonium. Analytical procedures are applied in a number of steps in fuel element fabrication. Extremely high resolution techniques are developed for reactor and nuclear materials. Analytical methods used are: emission spectrometry, x-ray fluorescence, mass spectrometry, alpha and gamma spectrometry, coulometry, and activation analysis. Examples of typical procedures are given. (INIS-Sweden)

19583 ACTIVATION ANALYSIS WITHIN TECHNIQUE AND RESEARCH. Brune, D. (Aktiebolaget Atomenergi, Stockholm). Svensk Kem. Tidskr., 79: No. 2, 154-7(1967). (In Swedish).

Application of neutron activation analysis for the determination of atomic elements is discussed. Either one single element or a large number can be simultaneously identified in trace quantities. The method is applied both in inorganic and organic matrixes and the neutrons can be at any energy level. (INIS-Sweden)

19584 AUTOMATIC CONTROL APPARATUS FOR ACTIVATION ANALYSIS. (to Tokyo Shibaura Electric Co. Ltd.). British Patent 1,055,657. Jan. 18, 1967. Priority date May 27, 1963, Japan.

A completely automatic device for activation analysis transfers the sample to an irradiation position, initiates the irradiation, monitors the amount of radiation, and moves the sample from the irradiation position to a counting position when the desired amount of irradiation has taken place. The monitor receives an electrical signal from a detector for the radiations and derives from the electrical signal another signal representative of the radioactivity that would be induced in a reference body of known composition subjected to the same irradiation as the sample to stop the irradiation and to activate the transfer mechanism. (B.L.M.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 19720 and 19904.

19585 (AD-640952) CRYSTAL CHEMISTRY STUDIES. Quarterly Report No. 5, May 14–August 13, 1966. Roy, Rustum; McCarthy, G. J.; Muller, O.; Rault, M.; White, W. B. (Pennsylvania State Univ., University Park. Materials Research Lab.). Oct. 1966. Contract DA-28-043-AMC-01304(E). 16p. (ECOM-01304-5). CFSTI $3.00 cy, $0.65 mn.

Measurements were made on the rare earth rhenium oxides. The resistivity (approximately 20,000 ohm-cm) and evidence of some photoconductivity were found for single crystal Beta-Nd_2ReO_5. The densities of Yb_2ReO_5 (9.79 g/cc) and Beta-Nd_2ReO_5 (8.14 g/cc) were measured. The systems MoO_3–ReO_3 and WO_3–ReO_3 were examined with the conclusion that no solid solution exists between these components. An attempt at single crystal growth of ReO_3 was unsuccessful. Systematic work was started in the system $EuO-Eu_2O_3-TiO-TiO_2$. The compounds $EuTiO_3$, $Eu_2Ti_2O_7$, and a new compound Eu_2TiO_5 (possibly) have thus far been detected. Additional runs have been made in the systems $MgO-Cr_2O_3-O$, $CdO-Cr_2O_3-O$, and $NiO-Cr_2O_3-O$. High oxygen pressure studies of the system Cr–Fe–O have been resumed. (auth)

19586 (DP-MS-66-82) DIETHYLDITHIOCARBAMATES OF QUADRIVALENT ACTINIDES. Bibler, J. P. (Augusta Coll., Ga.); Karraker, D. G. (Du Pont de Nemours (E. I.) and Co.,

Aiken, S. C. Savannah River Lab.). Nov. 30, 1966. Contract AT(07-2)-1. 10p. (CONF-670401-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

Sulfur complexes of Th(IV), U(IV), Np(IV), and Pu(IV) were synthesized with the diethyldithiocarbamate ligand (L = $[S_2CN(C_2H_5)_2]^-$) by the reaction of LiL and the bis(tetraethylammonium)-hexachloro actinides(IV) or the actinide(IV) chlorides in anhydrous ethanol. The reaction yielded ThL_4, UL_4, NpL_4, and PuL_4. These compounds must be prepared and maintained in a dry, inert atmosphere because they react with water and oxygen. The compounds are assumed to be entirely sulfur-bonded; infrared spectral studies in the region assigned to C–S stretching frequencies (~1000 cm^{-1}) suggest that only the thorium ion is 8-coordinate, with all four diethyldithiocarbamate groups functioning as bidentate ligands. Uranium, neptunium, and plutonium complexes appear to contain both mono- and bidentate dithiocarbamate groups inferring a probable coordination number of 6 or 7 for these ions. The inability of U^{4+}, Np^{4+}, and Pu^{4+} to accommodate four bidentate sulfur ligands is attributed to the smaller size of these ions, compared to Th^{4+}. (auth)

19587 (IS-T-119) THERMODYNAMICS OF THE SOLUTION OF MERCURY METAL. Spencer, James Nelson (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 108p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The temperature dependence of the solubility of mercury in seventeen solvents has been measured. The solubilities at 25°C were found to vary from 10^{-5} to 10^{-6} moles/l for aromatic and aliphatic hydrocarbons and ethers and approximately 10^{-7} moles/l for water and perfluorodimethylcyclobutane. The partial entropies of solution of mercury were determined from the temperature dependence of the mercury solubilities. The experimental entropies were found to differ from ideal. Various factors which may contribute to this effect are discussed. The heats and entropies of vaporization of the mercury solute were also calculated. The free volume theory of solutions has been used to provide an interpretation of the solute-solvent interactions in these solutions. Evidence is presented for the structuring of water molecules about the solute. (72 references). (P.C.H.)

19588 (K-1689) DISSOCIATION PRESSURES AND PHASE EQUILIBRIA OF THE PENTAFLUOROANISOLE–BORON TRIFLUORIDE COMPLEX SYSTEM. Jones, C. G. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Apr. 3, 1967. Contract W-7405-eng-26. 218p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Using pentafluoroanisole (methoxypentafluorobenzene) as the donor molecule the effect on the strength of the addition complex of boron trifluoride and anisole produced by the substitution of fluorine atoms for hydrogen atoms on the benzene ring has been evaluated. The exothermic reaction of boron trifluoride gas with liquid pentafluoroanisole was readily carried out at temperatures below 0°C. The heat of dissociation of the reaction $C_6F_5OCH_3 \cdot BF_{3(l)} \rightleftharpoons C_6F_5OCH_{3(l)} + BF_{3(g)}$ was determined to be 8.7 kcal mole $mole^{-1}$. Equations were fitted to the dissociation pressure–temperature data for the temperature range of –60 to 20°C for pressures up to 279 cm Hg. The pressure-composition relation at constant temperature obeyed Henry's law up to about 0.6 mole ratio of boron trifluoride to pentafluoroanisole. The solid–liquid phase equilibria were also determined under the orthobaric pressure of boron trifluoride. The melting point of pentafluoranisole is –34.4°C and the best estimate of the melting point of the 1:1 mole ratio complex was –30.0°C. The eutectic point between pentafluoroanisole and the 1:1 mole ratio complex was observed at –45.5°C at an estimated composition of 0.31 mole ratio of boron trifluoride to pentafluoroanisole. Despite several advantages, the process using pentafluoroanisole as the exchange agent is not attractive commercially because of its high cost and refrigeration requirements. (P.C.H.)

19589 (TID-22570) CALCIUM HYDRIDE–RARE EARTH HYDRIDE SOLID SOLUTIONS. Messer, Charles E.; Miller, Roy M.; Barrante, James A. (Tufts Univ., Medford, Mass. Dept. of Chemistry). [nd]. Contract AT(30-1)-1355. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Studies were made on the Ca–rare earth–H systems using La and Y. For La the lines of the orthorhombic phase were missing in samples up to 50 to 60% Ca, and relatively weak beyond. The lines of the fcc phase persisted up to highest Ca content. This is interpreted as indicating extensive solid solubility of calcium hydride in fcc lanthanum hydride. For Y the orthorhombic CaH_2 phase was present in all samples, with much stronger line intensities than in the corresponding La samples. The fcc phase corresponding to YH_2 was present in the low-hydrogen series. With the exception of YH_3 in the low-hydrogen samples, the phases present were those expected in a mechanical mixture of the same overall composition with no interaction. (P.C.H.)

19590 (TID–23756) STUDIES IN MOLECULAR SPECTROSCOPY. I. ON THE MULTIPLICITIES OF PHOSPHORESCENT STATES OF ORGANIC MOLECULES. II. POLARIZATION OF THE ABSORPTION OF $UO_2(NO_3)_2 \cdot 6\ H_2O$ SINGLE CRYSTAL. III. THE ELECTRONIC STRUCTURE OF THE SULFUR–SULFUR BOND. O'Donnell, Charles Michael (Louisiana State Univ., New Orleans. Dept. of Chemistry). Aug. 1966. Contract AT(40-1)-2833. 85p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The value of the "multiplicity" g_u of organic molecules for use in the equation $k_p = 2\pi C\nu^2 n^2 (g_l g_u) \int \epsilon d\bar{\nu}$ is discussed and shown to lie in the range $1 \leq g_u \leq \infty$. The value best suited to most organic compounds at 77°K is shown to be $g_u = 3$. The number of emitting triplet components is shown to be readily derivable for large classes of compounds and to correlate with experiment. The effects of magnetic field strength on triplet component energies, phosphorescence lifetime, phosphorescence polarization, and g_u are calculated and shown to produce large effects in the specific case of naphthalene-d_8. Polarized luminescence and luminescence excitation spectra for $UO_2(NO_3)_2 \cdot 6\ H_2O$ have been measured in both glassy solutions and in the single crystal at 77°K. Results were not definitive. Absorption polarization of the single crystal at 77°K indicated that there are at least three different electronic transitions in the interval 20583 to 27000 cm^{-1}; these transitions, in order of increasing energy, are polarized perpendicular, parallel, and perpendicular, respectively, to the UO_2 "axis." A fourth electronic transition at 27263 cm^{-1} exhibited parallel polarization. The ultraviolet and NMR spectra were obtained for several simple disulfides, and semi-empirical molecular orbital calculations were performed to aid in a more valid interpretation of the sulfur–sulfur bond. (P.C.H.)

19591 (AEC-tr-6716) COPRECIPITATION AND ADSORPTION OF RADIOACTIVE ELEMENTS. Vdovenko, V. M. (ed.). Translation of Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov, Izdatel'stvo Nauka, Moscow–Leningrad, 1965. 229p. (IPST-Cat.–1804). CFSTI $3.00 cy, $0.65 mn. JCL $15.00 fs, $7.07 mf.

A cover-to-cover translation is presented for the book, which is a collection of original experimental and theoretical investigations on the coprecipitation and adsorption of radioactive isotopes. Thirty-one articles are included. (P.C.H.)

19592 (ORNL-tr-1594) ON THE SURFACE IONIZATION OF RARE EARTH ELEMENTS. Komori, Takumi; Tamura, Sbuzo; Gunji, Katsubumi; Toda, Kimiko. Translated for Oak Ridge National Lab., Tenn., from Shitsuryo Bunseki, 14: No. 1, 15-22 (1966). 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Factors such as the effect of filament temperature on the ions that are produced, the different ionic species produced (ratio between elemental ion and oxide ion) and relative ionization efficiencies were followed using mainly the triple filament method to observe the relative behavior of the rare earth elements during surface ionization. Some studies were also made by the single filament method as a basis of comparison. The ionization efficiencies of the light rare earths according to the triple filament method were roughly one order of magnitude greater than those of the heavy rare earths. Very little difference in efficiencies was found either in the light or in the heavy rare earth groups. (P.C.H.)

19593 USE OF CORRELATION EQUATIONS IN THE CASE OF THE ISOTOPIC EXCHANGE OF HYDROGEN IN THE FERROCENE SERIES. Nefedova, M. N.; Setkina, V. N.; Perevalova, E. G.; Kursanov, D. N.; Nesmeyanov, A. N. (Inst. of Elementary Organic Compounds, Moscow). Reakts. Sposobnost Org. Soedin., Tartu. Gos. Univ., 2: 69-83(Oct. 1965). (In Russian).

The hydrogen-exchange rate constants of 6 mono- and 4 disubstituted derivatives of ferrocene with CF_3COOD in various solvents were determined. The rate constants characterize the reactivity of the molecule. The rates of exchange in different positions (1,2,3) were not estimated. It was established the $\lg k/k_0$ ratio (where k and k_0 are the specific protium–deuterium exchange rate constants of substituted and unsubstituted ferrocene, respectively) depends linearly on the σ_p^0 constants without exception. In the case of heteroannular doubly substituted ferrocones the additivity rule was found to be present, and the respective experimental points are placed on the straight line for monosubstituted derivatives. The relative importance of inductive and resonance effects in the electrophilic protium–deuterium exchange in ferrocene is approximately as large as in the case of the side-chain reactions of benzene, i.e., the contribution of resonance effect is considerably smaller than in the electrophilic substitution in the benzene ring. It was proposed that the addition of the deuterium to the iron atom

in the 1st step of isotopic exchange reaction could be considered as the rate determining step. (auth)

19594 INVESTIGATION OF THE SOLVATING ABILITY OF ETHERS BY MEANS OF ISOTOPIC HYDROGEN EXCHANGE. Schatenshtein, A. I.; Bessonov, B. A.; Yakovleva, E. A. (Karpov Inst. of Physics and Chemistry, Moscow). Reakts. Sposobnost Org. Soedin., Tartu. Gos. Univ., 2: 253-66(Oct. 1965). (In Russian).

Hydrogen isotopic exchange techniques were used to investigate the solvating ability relative to the cations of the alkali metals, and the kinetics of deuterium exchange between fluorene-9d (FL) and p-CH_3O·acetophenone (MA) and between FL and indene (IN) in ethers of ethylene glycol and in cyclic ones, between FL and t-BuOH in the mixtures of the latter with ethers, between FL and IN in the ether-n-hexane (HX) mixtures was measured. It was concluded that independent of the solvent composition and concentration of lithium butoxide, the latter catalyses the reaction as hexamer, structure of which is invariant relative to the solvation of the catalyst, which strongly alters the activity of the latter. Results were compared with literature. A similarity between the ether rows, on the basis of equilibria and kinetics of various reactions and processes, was found. (auth)

19595 STEREOCHEMISTRY OF METAL COMPLEXES AS AN INDICATION OF f-ORBITAL PARTICIPATION IN THE METAL-LIGAND BONDING. Kettle, S. F. A.; Smith, A. J. (Univ. of Sheffield, Eng.). J. Chem. Soc. (A), No. 4, 688-92(1967).

The irreducible representations spanned by the seven f-orbitals in all common point group symmetries are given. Those point groups in which an irreducible representation is spanned by the f-orbitals but not by s-, p-, or d-orbitals are discussed, and molecular geometries that would be indicative of f-orbital participation described. A survey of the available crystal structure data is given and compared with the theory. Reference is made to the following compounds (among others): ThTe, K_2ThF_6, RaF_2, UO_3, UH_3, UN_2, UB_{12}, USi_2, U_3Si_2, $Na_4UO_8 \cdot 9H_2O$, $RbUO_2(NO_3)_3$, $NaUO_2(OCOCH_3)_3$, $CaUO_4$, UO_2F_2, $UO_2(NO_3)_2 \cdot 6H_2O$, $KPuO_2CO_3$, $(NH_4)PuO_2CO_3$, $RbAmO_2CO_3$, $KAmO_2F_3$, dioxides and oxyfluorides of lanthanides and actinides, lanthanide dihydrides, $KLaF_4$ and rare earth borides. (UK)

19596 SPECTROSCOPIC STUDIES OF INORGANIC FLUORO-COMPLEXES. PART I. THE ^{19}F NUCLEAR MAGNETIC RESONANCE AND VIBRATIONAL SPECTRA OF HEXAFLUORO-METALLATES OF GROUPS IVA AND IVB. Dean, P. A. W.; Evans, D. F. (Imperial Coll. of Science and Tech., London). J. Chem. Soc. (A), No. 4, 698-701(1967).

The infrared, Raman, and ^{19}F NMR spectra of the hexafluoro-anions of the Group IV_A and IV_B elements were measured. It is concluded that the predominant species present in aqueous solutions of the ammonium salts are the octahedral AF_6^{2-} ions (except where A = Pb, when no definite conclusions could be drawn). In solution, the HfF_6^{2-} ion dissociates into HfF_5^{2-} and F^-. Fluorine exchange is much more rapid when A is Zr, Hf, or Pb than when A is Si, Ge, Sn, or Ti. The tin-fluorine coupling constants in the SnF_6^{2-} ion are appreciably solvent-dependent. (auth)

19597 LATTICE DYNAMICS AND THERMAL PROPERTIES OF LiH AND LiD CRYSTALS. Benedek, G. (Univ., Milan). Solid State Commun., 5: 101-4(Feb. 1967).

The vibrational spectra and the dispersion curves of LiH and LiD crystals were calculated in the framework of the Hardy deformation dipole model. Some anomalous features of the acoustic dispersion curves, which imply low lattice stability along some directions, are found for both crystals and discussed. The Debye θ's and moment functions are also evaluated. (auth)

19598 TRANSIENT PHENOMENA IN THE GASIFICATION OF GRAPHITE BY HIGH-PURITY CARBON DIOXIDE. Shelef, M.; Walker, P. L. Jr. (Pennsylvania State Univ., University Park). Contract AT(30-1)-1710. Carbon, 5: 93-105(Apr. 1967).

A study of the reaction of very pure graphite with thoroughly purified CO_2 emphasized the role which trace amounts of gaseous and surface impurities play in the kinetics of carbon gasification. The gasification of well-outgassed graphite proceeded temporarily at rates exceeding by more than an order of magnitude the gasification rates observed in systems to which minute amounts of hydrogen-containing gases and CO had access. The kinetics of this transient gasification are explained by a model involving two kinds of surface oxides, differing in reactivity. One surface oxide is formed on sites exceedingly sensitive to contamination. It possesses a high reactivity, i.e., a relatively short average lifetime on the surface. This is the surface oxide associated with the high rate. The second surface oxide is the more stable species, and is the intermediate in steady-state gasification. The decay of the transient rate is associated with the transition, with time, of the more reactive surface oxide into the relatively stable type. The devised mechanism generates rate-time curves in agreement with the experimental data. The amount of oxides on the surface after the decay of a transient gasification was estimated, and satisfactorily accounted for in the proposed model. (auth)

19599 STUDY OF THE IGNITION OF GRAPHITE. Goard, P. R. C.; Mulcahy, M. F. R. (CSIRO, New South Wales, Australia). Carbon, 5: 137-53(Apr. 1967).

The ignition of electrically heated rods of spectroscopic graphite subjected to transverse streams of oxygen or air at various velocities was studied. Pre-ignition combustion occurred within the pores of the graphite but did not completely penetrate the rod (0.6 cm dia); the conditions for ignition are therefore partly determined by the diffusion of oxygen into the pores. Ignition was facilitated by oxidizing the graphite prior to testing, and hindered by depositing pyrolytic carbon in the pores. The conditions for ignition are discussed with reference to the theory of Frank-Kamenetskii, extended to include the effect of pore-diffusion on the combustion kinetics. The practicability of calculating ignition temperatures from published kinetic data and physical properties was explored in detail. It was concluded that the accuracy of the calculations is limited severely by uncertainties in the kinetic data and in knowledge of the degree of activation of the graphite (or other carbon) by the oxidant before ignition. (auth)

19600 FLUORESCENCE SPECTRUM OF THE BENZYL RADICAL TRAPPED AT LOW TEMPERATURE IN SOME CRYSTALLINE MATRICES: METHYLCYCLOHEXANE, CYCLOPENTANE, AND METHYLCYCLOPENTANE. Ripoche, J. (Faculte des Sciences, Rennes, France). Spectrochim. Acta, 23A: 1003-21(Apr. 1967). (In French).

A quasi-linear fluorescence spectrum of the benzyl radical $C_6H_5CH_2$ and the deuterated benzyl radical $C_6D_5CD_2$ trapped at 88°K in three crystalline matrixes (methylcyclohexane, cyclopentane and methylcyclopentane) was observed. The benzyl radical was formed by photochemical decomposition of toluene. A vibrational analysis of the spectra was proposed and fourteen fundamental frequencies were assigned. A comparison is given with previous results for the benzyl radical trapped in a crystalline matrix of cyclohexane and the results for toluene studied by infrared spectrometry. (auth)

19601 SYNTHESIS OF PHTHALOCYANINES OF SOME HEAVY METALS. Kirin, I. S.; Moskalev, P. N.; Mishin, V. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Obshch. Khim., 37: 280(Jan. 1967). (In Russian).

Uranium, thorium, hafnium, antimony, and bismuth phthalocyanines were synthesized at 250 to 300°C using o-phthalonitrile and acetates of U_2^{4+}, Th^{4+}, Hf^{4+}, Sb^{3+}, and Bi^{3+} as initial products. The maximum absorption bands for the products of reaction synthesis were 646 and 695μ for thorium, 632, 665, and 698μ for hafnium, 642, 659, and 706μ for bismuth, and 670 and 690μ for antimony phthalocyanines. The thorium and hafnium spectra were obtained in benzene and antimony and bismuth in dimethyl formamide. (R.V.J.)

19602 ISOTOPE EFFECTS ON FRANCK-CONDON FACTORS. VII. VIBRATIONAL INTENSITY DISTRIBUTION IN THE H_2 LYMAN, H_2 WERNER, O_2 SCHUMANN-RUNGE, N_2 FIRST POSITIVE, N_2 VEGARD-KAPLAN, AND LiH (A-X) SYSTEMS BASED ON RKR POTENTIALS. Halmann, M.; Laulicht, I. (Weizmann Inst. of Science, Rehovoth, Israel). J. Chem. Phys., 46: 2684-9(Apr. 1, 1967).

Franck-Condon factors, based on Rydberg-Klein-Rees (RKR) potential functions, were computed for the H_2 and D_2 Lyman and Werner, $^{16}O_2$ and $^{18}O_2$ Schumann-Runge, $^{14}N_2$ and $^{14}N^{15}N$ first positive and Vegard-Kaplan, and ^{7}LiH and ^{7}LiD (A-X) band systems. While the vibrational intensity distribution within several band series differs considerably from that previously computed using Morse potentials, the isotope effect is very similar by both methods. Only for the hydrogen Lyman bands, is the isotope effect on Franck-Condon factors markedly different by the two methods. The isotope ratio of Franck-Condon factors, $q(^7LiH)/q(^7LiD)$, in a given band progression (e.g., $v'' = 3$), oscillates between very large (10^4) and very small (10^{-2}) values at the minima between the locus of the Condon parabolas. The isotope effect on r centroids is negligible for transitions of oxygen and nitrogen molecules, but amounts to several percent for transitions of hydrogen and lithium hydride molecules. For the $^{16}O_2$ Schumann-Runge absorption bands, the variation of the electronic transition moment R_e with internuclear distance r is represented by $R_e = \text{const}(1 - 0.70r)$. (auth)

19603 PHOTOEXCITED ISOTOPIC EXCHANGE IN THE SOLID STATE: $^{57}Co^{2+}$-DOPED COBALT CHELATES. Nath, Amar; Khorana, S. (Atomic Energy Establishment, Trombay, India). J. Chem. Phys., 46: 2858-9(Apr. 1, 1967).

Isotopic exchange in the solid state for $^{57}Co^{2+}$-doped cobalt

chelates was interpreted on the basis of the "variable-depth electron-donors isotopic exchange" model according to which electrons freed from crystal imperfections by thermal or photon activation may be captured by the dopant $^{57}Co^{2+}$ to form the excited species $^{57}Co^{+}$, which exchanges with a neighboring cobalt chelate molecule. The maximum amount of exchange took place with light between 5000 and 5500 Å for all the complexes tested. Results supported the model. (M.C.G.)

19604 NITROGEN-ISOTOPE EFFECTS IN THE REDUCTION OF NITRATE, NITRITE, AND HYDROXYLAMINE TO AMMONIA. I. IN SODIUM HYDROXIDE SOLUTION WITH Fe(II). Brown, L. L.; Drury, J. S. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 46: 2833-7(Apr. 1, 1967). (ORNL-P-2674).

Studies were made of the nitrogen isotope effects occurring during the alkaline reduction of NO_3^-, NO_2^-, and NH_2OH with Fe(II). The pertinent reduction reactions were shown to be irreversible and the yields of NH_3 quantitative. The reduction of NO_3^- to NH_3 produced a k^{14}/k^{15} value of 1.075 ± 0.004 at 25°C. A k^{14}/k^{15} ratio of 1.034 ± 0.002 at 25°C was obtained for the reduction of NO_2^-, or NH_2OH to NH_3. The rate constant, $k_{NO_3^-}$, was shown to be slow compared to $k_{NO_2^-}$ and k_{NH_2OH}, which had values of 4.09×10^{-2} and 9.53×10^{-3} sec^{-1}, respectively. The experimental data agreed well with results computed for a two-atom model in which the significant step in the reduction of each species was the breaking of an N–O bond. Reactions consistent with the experimental data were proposed to account for the reduction mechanism. (auth)

19605 ELECTRODE PROCESSES DURING REDUCTION OF URANIUM COMPOUNDS IN NITRATE SOLUTIONS. Stabrovskii, A. I. Zh. Neorg. Khim., 11: 845-53(Apr. 1966). (In Russian).

It was established that at low acidity of the nitric acid solution (pH ~ 4) the reduction of uranyl ions on the Hg dropping electrode proceeded in two stages. The first wave on the polarogram of uranyl ions with potential half-wave + 0.06 V caused the reduction of U(VI) to U(V) and the second wave with potential half-wave of only 0.7 V to the reduction of U(V) to U(IV). With increased acidity of the solution the reduction of U(IV) and nitrate ions also occurred and this reduction occurred at the same potential at which U(V) and U(IV) were reduced. It was shown that the height of the wave of the first reduction of the uranyl ions in nitric acid solution depended on the acidity of the solution. With an increase in the acidity of the solution the limiting current of the reduction wave of U(VI) to U(V) was increased. This increase of current is explained by an increase of the compensation of uranyl ions in the approximate electrode layer with the resulting disproportionation of U(V) to U(VI) and U(IV). It was explained that the reduction of the nitrate ions in solutions containing U(VI) or U(IV) salts occurred only in those cases where the conditions for the reduction of U(VI) or U(IV) on the dropping electrode to U(III) were produced. The nitrate ions were reduced with U(III) ions formed as a result of the primary process. The number of electrons participating in the oxidation–reduction reaction was determined. (tr-auth)

19606 PREPARATION OF THORIUM COMPOUNDS WITH OXALATE, CARBONATE AND SULFITE IONS. Essen, L. N.; Alekseeva, D. P.; Gel'man, A. D. (Inst. of Physical Chemistry, Moscow). Zh. Neorg. Khim., 11: 1596-1604(July 1966). (In Russian).

The following thorium oxalate carbonate compounds were prepared in the solid state: $Na_{10}Th(C_2O_4)_3(CO_3)_3(OH)_2 \cdot 8$ to $9H_2O$, $K_4Th(C_2O_4)(CO_3)_3 \cdot 6H_2O$, $Na_8Th(C_2O_4)_2(CO_3)_4 \cdot nH_2O$, $K_8Th_2(C_2O_4)_3(CO_3)_5 \cdot 16H_2O$, $Na_{10}Th(C_2O_4)_2(CO_3)_5 \cdot nH_2O$, $K_{10}Th_2(C_2O_4)_2(CO_3)_7 \cdot 14H_2O$, $Na_8Th(C_2O_4)(CO_3)_5 \cdot 10H_2O$, $K_6Th(C_2O_4)(CO_3)_4 \cdot 8H_2O$, $Na_{12}Th(C_2O_4)_2(CO_3)_6 \cdot 13H_2O$, and $(CN_3H_6)Th_2(C_2O_4)(CO_3)_8 \cdot 8H_2O$. The following oxalate-sulfite and sulfite compounds of Th were prepared: $Na_6Th(C_2O_4)_2(SO_3)_3 \cdot 6H_2O$, $Na_{14}Th(C_2O_4)_2(SO_3)_7 \cdot 5H_2O$, $Na_6Th(C_2O_4)_2(SO_3)_4 \cdot 6H_2O$, $Na_{18}Th(C_2O_4)_2(SO_3)_9 \cdot 6H_2O$, $Na_{10}Th(C_2O_4)_2(SO_3)_5 \cdot 5$ to $6H_2O$, $Ba_6Th(C_2O_4)_2(SO_3)_6 \cdot 7H_2O$, $Na_{12}Th(C_2O_4)_2(SO_3)_6 \cdot 6$ to $8H_2O$, and $Na_4Th(SO_3)_4 \cdot 3H_2O$. (tr-auth)

19607 THORIUM NITRATE REACTIONS WITH o-PHTHALIC ACID. Kovalenko, K. N.; Kazachenko, D. V.; Vishnevetskaya, A. N. (Rostov-on-Don State Univ., USSR). Zh. Neorg. Khim., 11: 1626-30(July 1966). (In Russian).

By the method of the continuous change of the concentration of Ostromuslensk-Zhob, the thorium nitrate–o-phthalate system in water was investigated. The electric conductivity, pH, and Th concentration in the liquid phase of the system were measured. It was established that thorium nitrate enters into an exchange reaction with o-phthalate in aqueous solution with the formation of thorium diphthalate with the composition $Th(C_8H_4O_4)_2 \cdot 2H_2O$. Thorium diphthalate is highly soluble in aqueous solutions of nitric and hydrochloric acid at pH ≅ 1. In akaline media it is comparatively stable. In organic solvents (ethyl ether, ethyl and methyl alcohols, acetone, dioxane, and benzene) it is practically insoluble. A thermographic analysis was made and the density was determined. It is equal to 2.286 g/cm^3 at 20°C. (tr-auth)

19608 THORIUM GLYCOLATES. Kazachenko, D. V.; Kovalenko, K. N. (Rostov-on-Don State Univ., USSR). Zh. Neorg. Khim., 11: 1631-6(July 1966). (In Russian).

Study of the interaction of thorium nitrate and certain organic acids was continued, and data are given on the systems $Th(NO_3)_4 - CH_2OHCOONa - H_2O$ and $Th(NO_3)_4 - CH_2OHCOONa - NaOH - H_2O$ at 25°C. The electric conductivity, pH, and thorium concentration in the liquid phases of the systems were measured, and the precipitates were analyzed. It is shown that in the first system, an exchange reaction forms thorium tetraglycolate $Th(CH_2OHCOO)_4 \cdot 2H_2O$, and in the second system, up to a 1:4 molar ratio of the components, basic thorium diglycolate $ThO(CH_2OHCOO)_2 \cdot 2H_2O$ is formed; when sodium glycolate and sodium hydroxide are present in greater excess, the hydrolysis is more extensive. The reaction of thorium nitrate with glycolic acid was studied in acetone solution, and it was found that a basic thorium triglycolate with partly nitrated glycolate groups ($CH_2ONO_2COO^-$) was formed. (ATD)

19609 THE SYSTEM KF–UO_3–H_2O. Opalovskii, A. A.; Kuznetsova, Z. M. Zh. Neorg. Khim., 11: 1714-19(July 1966). (In Russian).

Isothermal solubility in the KF – UO_3 – H_2O system was studied. The solubility of UO_3 was initially increased by increasing the KF concentration in the solution and attained a maximum 1.87% at concentrations of KF equal to 3.58% in the solution and then abruptly decreased. In concentrated aqueous solutions of KF the solubility of UO_3 was 0.01%. At concentrations of KF in solutions greater than 10 to 12% the solid phase has the composition $K_2UO_3F_2 \cdot 2H_2O(K_2O_2(OH)_2F_2 \cdot H_2O)$. The thermal decomposition of this compound leads to the formation of a new compound with the composition $K_2UO_3F_2$. Chemical, thermographic, x-ray, and crystallographic studies were made of the solid phase of the KF – UO_3 – H_2O system. (tr-auth)

19610 URANIUM PRECIPITATION ON A CATHODE FROM FLUORIDE–CHLORIDE MELTS. Koryushin, A. P.; Smirnov, M. V.; Komarov, V. E. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial, No. 9, 73-82(1966). (In Russian).

Cathode polarization of molybdenum, platinum, and copper cathodes in fluoride–chloride melts containing 5 and 15 wt % U with fluoride to uranium ratio from 15 to 35 was studied at 973 and 1073°K. It was found that uranium precipitation at a cathode is followed by alloy formation with the material on which it settled. The potentials of free metallic uranium precipitation coincide with the equilibrium uranium electrode potentials in corresponding solutions. (R.V.J.)

19611 REFLECTION AND EMISSION FACTORS OF UO_2 AT HIGH TEMPERATURE. Cabannes, Francois; Stora, Jean-Paul; Tsakiris, Jean (CNRS, Bellevue, France. CEN, Grenoble, France). Compt. Rend., Ser. B, 264: 45-8(Jan. 4, 1967). (In French).

By use of the modulated-incident-flux method, the monochromatic factor of reflection was measured in the infrared and the red. The emission factor was deduced and it was shown that it is necessary to correct the values cited in the literature. (tr-auth)

19612 OXYGEN POTENTIALS IN THE US–UOS–UO_2 SYSTEM AS MEASURED BY SOLID-STATE GALVANIC CELLS. Yuill, William A. Jr.; Cater, E. David (Univ. of Iowa, Iowa City). Contract AT(11-1)-1182. J. Phys. Chem., 71: 1436-41(Apr. 1967). (COO-1182-12).

Solid-state galvanic cells were used to determine the partial pressure of oxygen over the three-phase system uranium monosulfide, uranium oxysulfide, and uranium dioxide in the temperature range from 1050 to 1350°K. The partial pressure of oxygen (based on the data of Worrell for the electrode Ta, Ta_2O_5) is given by the expression $\log P_{O_2}$ (atm) = (–14,700/T) – 10.5. The emf of the cell Ta, $Ta_2O_5|ThO_2$ $(0.07Y_2O_3)|US$, UOS, UO_2 between 1148 and 1350°K is given by E(mv) = $[(1.360 \pm 0.037) \times 10^3] - (0.942 \pm 0.029)T$. Data taken with Ta, Ta_2O_5 and Nb, NbO reference electrodes are in good agreement. (auth)

19613 ANOMALOUS TEMPERATURE DEPENDENCE OF KINETIC CARBON ISOTOPE EFFECTS. Yankwich, Peter E.; Buddenbaum, Warren E. (Univ. of Illinois, Urbana). J. Phys. Chem., 71: 1185-95(Apr. 1967). (COO-1142-67).

Six reactions studied between 200 and 600°C and 22 investigated between –30 and 180°C were examined for abnormalities in the temperature dependence of the observed kinetic carbon isotope effects. A system of classification was developed and two theoretical approaches applied in detail to 16 reactions in the lower tempera-

ture range, most of which are decompositions in solution. A phenomenon similar to the crossover with changing temperature of isotopic exchange equilibrium constants can explain all of the results except those where the temperature-dependence abnormality and the gross isotope effect simultaneously are large. Alternatively, all of the experimental anomalies could originate in differences between transition states associated with two competing reaction paths, access to which is controlled by an enthalpy difference. Tests of the data revealed that only in a small number of cases could washout of equilibrium isotope effects (e.g., arising in complexing by solvent) account for the experimental findings. (auth)

19614 DETERMINATION OF STABILITY CONSTANTS BY DONNAN MEMBRANE EQUILIBRIUM: THE URANYL SULFATE COMPLEXES. Wallace, Richard M. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. J. Phys. Chem., 71: 1271-6(Apr. 1967). (DP-MS-66-43).

A method for the determination of stability constants of inorganic complexes was developed. The distribution of the cation of interest between complexing and noncomplexing solutions separated by a permselective membrane was measured simultaneously with that for an unreactive univalent cation. Stability constants were calculated from this distribution and from conditions necessary for Donnan equilibrium across permselective membranes. This method was applied to the reactions between uranyl and sulfate ions. The equilibrium constants for the reactions $UO_2^{2+} + SO_4^{2-} \rightleftharpoons UO_2SO_4$ (I) and $UO_2^{2+} + 2SO_4^{2-} \rightleftharpoons UO_2(SO_4)_2^{2-}$ (II) were determined at 25, 35, and 50°C. The measurements were made at ionic strengths between 0.15 and 0.01M, and the results were extrapolated to zero ionic strength. The stability constants (in terms of activity) were K_I = 1390, 1830, and 2700 at 25, 35, and 50°C, respectively, for reaction I and $K_{II} = 1.61 \times 10^4$, 2.31×10^4, and 3.97×10^4 at the same respective temperatures for reaction II. ΔH_I and ΔH_{II} were calculated to be 5.0 and 6.98 kcal/mole, respectively. (auth)

19615 DEHYDROGENATION MECHANISMS. ON THE MECHANISM OF DEHYDROGENATION OF ACENAPHTHENE BY QUINONES. Trost, Barry M. (Univ. of Wisconsin, Madison). J. Amer. Chem. Soc., 89: 1847-51(Apr. 12, 1967).

The mechanism of the dehydrogenation of acenaphthene by quinones was investigated. Dehydrogenation of cis-1,2-dideuterioacenaphthene utilizing 2,3-dichloro-5,6-dicyanobenzoquinone proceeded with 77.7% cis elimination and employing tetrachloro-o-benzoquinone with 62.9% cis elimination. These data require modification of the existing mechanism of dehydrogenation. The large isotope effect, the lack of 1,2 shifts, and the stereochemistry of elimination support the intermediacy of classical carbonium ions. Initial ion-pair formation and partial collapse of the ion pair to product before dissociation accounts for the observed net cis elimination. The amount of net cis elimination decreases as solvent polarity increases, an observation in support of the ion-pair hypothesis. (auth)

19616 7,12-DIHYDROPLEIADENES. V. TRANSANNULAR 1,4-HYDRIDE REARRANGEMENTS IN 1-SUBSTITUTED 7-HYDROXY-12(7H)-PLEIADENONES. Lansbury, Peter T.; Saeva, Franklin D. (State Univ. of New York, Buffalo). J. Amer. Chem. Soc., 89: 1890-5(Apr. 12, 1967).

1-Chloro-7-hydroxy-12(7H-pleiadenone rearranges by intramolecular 1,4-hydride migration to 1-chloro-12-hydroxy-7(12H)-pleiadenone when treated with alkali metal t-butoxides in dimethyl sulfoxide. The rate-determining step is the transannular hydride rearrangement of the initially formed alkoxide and has $E_4 \sim 24$ kcal/mole for the potassium salt in 95:5 DMSO–t-butyl alcohol. The primary deuterium isotope effect and metal cation effects on the rearrangement are also reported. The isomeric reactant and product hydroxy ketones both exhibit ring–chain tautomerism in solution. (auth)

19617 EFFECTS OF UNIAXIAL STRESS AND ELECTRIC FIELDS ON LOCALIZED VIBRATIONAL MODES OF H^- AND D^- IONS IN CaF_2. Hayes, W.; Macdonald, H. F. (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 297: 503-19(Mar. 21, 1967).

A description is given of the effects of stress and electric fields on the fundamental and second harmonic localized vibrational levels of H^- and D^- ions in CaF_2. Electric dipole transitions are allowed from the singlet Γ_1 ground state to the triply degenerate Γ_5 excited states and the absorption lines are sufficiently narrow at low temperatures (ca 1 cm^{-1}) to enable splitting of the Γ_5 states by the external perturbations to be measured. The measured splittings are a factor of approximately $\sqrt{2}$ smaller for D^- ions than for H^- ions. Transitions to the second harmonic Γ_3 and Γ_1 levels, which cannot be observed in unperturbed crystals, were found in stressed crystals due to stress-induced admixture of the nearby second harmonic Γ_5 state. (auth)

19618 THERMAL DEGRADATION OF VINYL POLYMERS. III. A RADIOCHEMICAL STUDY OF INTERMOLECULAR CHAIN TRANSFER IN THE THERMAL DEGRADATION OF POLYSTYRENE. Richards, D. H.; Salter, D. A. (Explosives Research and Development Establishment, Waltham, Eng.). Polymer, 8: 153-9(Mar. 1967).

The importance of an intermolecular chain transfer reaction in the thermal degradation of polystyrene was established by a radiochemical method. A polystyrene containing a specific number of thermally weak links at known points along the polymer chain was prepared by an adaptation of the Szwarc "living" polymer technique and thermally degraded at moderate temperatures (280 to 285°C) in the presence of ^{14}C-labelled "normal" polystyrene as diluent. Measurement of the activity of the monomer in the distillate showed that, with a kinetic chain length of about three monomer units, 1.2 chain transfers occurred per radical. Some evidence is also given to indicate that weak-link scission plays a significant role in the early stages of polystyrene degradation. (auth)

19619 STANDARD HEATS OF FORMATION OF OXIDES AND HEXABORIDES OF RARE EARTH ELEMENTS. Timofeev, V. A.; Timofeeva, E. N. Zh. Neorg. Khim., 11: 1233-5(1966). (In Russian).

A comparison is given of the standard heats of formation, reported in the literature and calculated according to A. F. Kapustinskiy's rule of oxides and hexaborides of rare earth elements. [The Kapustinskiy rule: $\Delta H/w = a \log Z + b$ is claimed to be valid for elements within one subgroup of the periodic system; where ΔH is the standard heat of formation, w is valence of a rare earth element, a and b are empirical constants, and Z is specific atomic number.] An excellent agreement between the literature data on standard heats of formation and the calculated values (according to the Kapustinskiy rule) was found for the oxides as well as for the hexaborides of the rare earth elements. (ATD)

19620 INFRARED ABSORPTION SPECTRA OF THORIUM SULFATE COMPOUNDS. Evstaf'eva, O. N.; Molodkin, A. K.; Dvoryantseva, G. G.; Ivanova, O. M.; Struchkova, M. I. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim., 11: 1306-15(1966). (In Russian).

The infrared spectra at 400 to 4,000 cm^{-1} of the following hydrated sulfate and sulfate complex compounds of Th were prepared: $Th(SO_4)_2 \cdot 4H_2O$; $Me_2Th(SO_4)_3 \cdot xH_2O$ (Me = NH_4, x = 5; K, x = 4; Cs, x = 2; $\frac{1}{2}NaNH_2C(NH_2)_2$, x = 6); $Me_4Th(SO_4)_4 \cdot xH_2O$ (Me = K, x = 2; NH_4, x = 2; Rb, x = 0); $Me_6Th(SO_4)_5 \cdot 3H_2O$ (Me = NH_4, Cs); $(NH_4)_8Th(SO_4)_6 \cdot 2H_2O$. The character of the spectra indicated the presence of coordinately bound sulfate groups. The very complex spectra of the compounds is connected with the presence of multicharacter sulfate groups and with the great variety of different distances S–O. The simple spectra of compounds with a Th : SO_4 ratio other than 1 : 4 (with greater or less concentration of the sulfate group) indicates the great homogeneity of the sulfate groups in these compounds. From analogous spectra of similar compounds with different cations, conclusions were made on the comparatively small effect of the cations in the compounds studied on the structure of thorium sulfate complexes. Coordination formulas of hydrated sulfates and sulfate compounds of Th were proposed: $[Th(SO_4)_2(H_2O)_4]$; $K_2[Th(SO_4)_3(H_2O)m] \cdot (4 - m)H_2O$; $Cs_2[Th(SO_4)_3(H_2O)_2]$; $NaC(NH_2)_3[Th(SO_4)_3(H_2O)m](6 - m)H_2O$; $Rb_4[Th(SO_4)_4]$; $(NH_4)_8[Th(SO_4)_5(H_2O)m](3 - m)H_2O$; $Cs_8[Th(SO_4)_5 \cdot (H_2O)m](3 - m)H_2O$; $(NH_4)_8[Th(SO_4)_6H_2O] \cdot H_2O$. (tr-auth)

19621 THORIUM OXALATE SOLUBILITY COMPOSITION AND DISSOCIATION CONSTANTS FOR THORIUM OXALATE COMPLEXES IN AQUEOUS SOLUTIONS. Moskvin, A. I.; Essen, L. N. Zh. Neorg. Khim., 12: 688-93(Mar. 1967). (In Russian).

Solubility of $Th(C_2O_4)_2 \cdot 6H_2O$ and stability constants for thorium oxalate complexes were determined using data on the $Th(C_2O_4)_2 \cdot 6H_2O$ solubility in perchloric acid and oxalate solutions. The data obtained indicated that $Th(C_2O_4)_2 \cdot 6H_2O$ solubility with (μ = 1) is 4.2×10^{-22} and with (μ = 0) it is 1.1×10^{-25}. Complex ions of $[Th(C_2O_4)]^{2+}$, $[Th(C_2O_4)_2]^0$, and $[Th(C_2O_4)_3]^{2-}$ were found. The general concentrated stability constants for the above complexes were 1.7×10^9, 5.9×10^{16}, and 5.9×10^{22} (at μ = 1), respectively. (R.V.J.)

19622 THERMODYNAMIC CONSTANTS FOR U^{4+} COMPLEXING WITH OH^- IONS AND Zr^{4+} WITH OH^- AND NO_3^- IONS. Solovkin, A. S.; Tsvetkova, Z. N.; Ivantsov, A. I. Zh. Neorg. Khim., 12: 626-32(Mar. 1967). (In Russian).

Thermodynamic constants of metal ions complexing with inorganic addends in aqueous solutions were calculated using the intrinsic activity coefficients of ions participating in complexing reactions. The complexing constants obtained were used for calculating equilibrium in homogeneous and heterogeneous systems with electrolyte concentrations in solution up to 3 to 5 g/equiv/l. The mean thermodynamic constant for U^{4+} ion hydrolysis in the

$HClO_4-NaClO_4$ system at [U] = 10^{-4} to 10^{-5} mole was K_m^0 = (7.73 ± 0.69) × 10^{-2}. Experimental data are tabulated for the complexing of Zr^{4+} with NO_3^- ions in $HClO_4-HNO_3$ [H^+] = 2.0 g/ion/l. Absence of complexing between the Zr^{4+} ions and NO_3^- ions in $HNO_3 \leq 2$ mole was observed during the experiments. (R.V.J.)

19623 SOME NEW ASPECTS OF THE MECHANISM OF HYDROGEN EXCHANGE AND HYDROGENATION REACTIONS OVER METAL CATALYSTS. CATALYTIC EXCHANGE REACTION BETWEEN METHANE AND TRITIUM ON Ni CATALYST. Guczi, L.; Tetenyi, P. (Inst. of Isotopes, Budapest). Acta Chim. Acad. Sci. Hung., 51: 275-83(1967).

Experiments were carried out on the isotope exchange between CH_4 and HT on Ni catalyst. The kinetics of the reaction was studied and the activation energy value was calculated. The exchange between H−T and H_2 was quicker than that between CH_4 and HT. This fact is in accordance with the results of thermodynamic calculations and can be explained by the more rapid adsorption of hydrogen. (auth)

19624 A STUDY OF THE PROTOLYTIC EQUILIBRIUM OF PHENOSAFRANINE IN NITRIC ACID SOLUTIONS OF URANYL NITRATE. Klygin, A. E.; Zhuravlev, G. I.; Kolyada, N. S. Zh. Anal. Khim., 22: 317-24(Mar. 1967). (In Russian).

The equilibrium of phenosafranine (RH^+)−nitric acid−uranyl nitrate can be described by the following equation: $RH^+ + H^+ + NO_3^- = [RH \cdot HNO_3]^+$. This equation is true within the concentrations from 20 to 200 g/l of uranyl nitrate and from 0.1 to 3M of nitric acid. Using the method of least squares, calculations of the formation constant of the $[RH \cdot HNO_3]^+$ ion (K = 1.19) and the molar-extinction coefficients of phenosafranine and its complex with nitric acid at 580 and 620 nm were made. It was established that knowing the equation for the relation between the formation constant, the molar-extinction coefficients, the concentrations of the components in the solution, and its optical density it is possible to simultaneously determine the content of nitric acid and uranyl nitrate in the solution. The method of least squares can be used as an additional criterion for the estimation of the probability of the suggested processes proceeding in the solution. (auth)

19625 ACIDITY FUNCTIONS H_R^+ AND D_R^+: SOLVENT ISOTOPE EFFECT ON THE IONIZATION EQUILIBRIUM OF SOME TRIARYLMETHANOLS IN SULPHURIC ACID AND DIDEUTEROSULPHURIC ACID. De Fabrizio, Ennio (Univ., Rome. CNR, Padua). Ric. Sci., 36: 1321-9(Dec. 1966).

Thermodynamic and theoretical considerations led to the conclusion that in the range of 1 to 10M acid, acidity function H_R^+ in sulfuric acid has the same value as function D_R^+ in dideuterosulfuric acid. In this region of acidity the ionization of tertiary alcohols occurs through the processes: $Ar_3C^+ + 2H_2O = Ar_3COH + H_3O^+$ (K_H) and $Ar_3C^+ + 2D_2O = Ar_3COD + D_3O^+$ (K_D), where K_H is greater than K_D by a factor of about 2.5. In the range 86 to 97% acid the stoichiometry of alcohol ionization changes according to the processes: $Ar_3C^+ + H_3O^+ + 2HSO_4 = Ar_3COH + 2H_2SO_4$ (K_H) and, $Ar_3C^+ + D_3O^+ + 2DSO_4 = Ar_3COD + 2D_2SO_4$ (K_D) where K_H has about the same value as K_D. The application of the theory of the solvent isotope effect to these equilibria leads to the following results: K_H/K_D = 2.3 Experimental values = 3.4 and 2.3, K_H/K_D = 1.2 Experimental value = 0.8. (auth)

19626 SOME REACTIONS OF TECHNETIUM WITH THIOUREA AND SUBSTITUTED THIOUREAS. Lederer, Michael; Roch, Gilberto (Univ., Rome. CNR, Rome). Ric. Sci., 36: 1354-7 (Dec. 1966).

The reactions of technetium of various valencies with thiourea and the reactions of pertechnetate with phenylthiourea and diphenylthiourea were studied. Tc(VII), Tc(V), and Tc(IV) produce the same orange thiourea complex on heating with an excess of thiourea in HCl. In the cold Tc(V) yields another complex, presumably the Tc(V) thiourea complex. Phenylthiourea reacted like thiourea with pertechnetate, while diphenylthiourea reacted only slowly, via a yellow intermediate, and always in poor yield. (auth)

19627 STUDY ON TWO CRITERIA OF ZIRCONIUM PURITY. Renucci, Louis; Langeron, Jean-Paul (Centre d'Etude de Chimie Metallurgique, Vitry-sur-Seine, France). Compt. Rend., Ser. C, 264: 673-6(Feb. 20, 1967). (In French).

A study was made on the specific influence of impurities on the electric resistivity of Zr, measured at liquid hydrogen temperature after annealing at 650°C, and on the recrystallization temperature of Zr. Coefficients of the influence of the preponderant impurities, oxygen and nitrogen, on the resistivity as well as that of the metallic elements on the temperature of recrystallization of Zr were determined. (tr-auth)

19628 MOLAR VOLUMES IN THE LiF–ThF_4 SYSTEM. Hill, D. G.; Cantor, S.; Ward, W. T. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Inorg. Nucl. Chem., 29: 241-3(Jan. 1967). (ORNL-P-2167).

To determine if LiF−ThF_4 melts would exhibit significant departures from ideality of molar volumes, densities were measured at approximately 20 mole % composition intervals using the Archimedean method. The molar volumes in this system were found to be ideal; moreover, the expansivities, derived from temperature coefficients of density, revealed no unusual changes with composition. Since the LiF−ThF_4 system is known to exhibit large deviations from ideality in other thermodynamic properties, it was concluded that either ordinary density measurements do not detect strong interactions in ionic fluoride melts or that strong interactions do not necessarily lead to significant contractions or expansions. (auth)

19629 PRECIPITATION FROM HOMOGENEOUS SOLUTION. I. ZIRCONIUM AND THORIUM CUPFERRATES. II. NICKEL AND PALLADIUM SALICYLALDOXIMATES. De, Anil K.; Sahu, Chittaranjan (Jadavpur Univ., Calcutta). Separation Sci., 2: 11-23(1967).

Methods are proposed for the precipitation of zirconium and thorium cupferrates and nickel and palladium salicylaldoximates from homogeneous solution. Zirconium cupferrate can be quantitatively precipitated from 7 to 10 vol. % sulfuric acid, dried at 100°C, and weighed as $Zr(C_6H_5N_2O_2)_4$, whereas thorium cupferrate, quantitatively precipitated at pH 1 to 3, must be ignited to ThO_2. The conventional method does not give quantitative precipitation of thorium cupferrate. Nickel is precipitated at pH 9 to 10.5 by salicylaldoxime in situ, dried at 120°C, and weighed as $Ni(C_7H_6O_2N)_2$, whereas palladium is precipitated from 2 to 2.5 vol. % sulfuric acid, dried at 110°C, and weighed as $PD(C_7H_6O_2N)_2$. The interferences due to some commonly associated ions can be eliminated by appropriate masking agents. (auth)

19630 PRECIPITATION OF ^{238}Pu(IV) OXALATE FROM HOMOGENEOUS SOLUTION. Abrahamson, S. G. (Mound Lab., Miamisburg, Ohio). J. Inorg. Nucl. Chem., 29: 842-4(Mar. 1967).

A method for the precipitation of Pu(IV) oxalate from homogeneous solution by the hydrolysis of dimethyl oxalate is described. The precipitate obtained is crystalline and easily retained on a coarse filter. The most decisive advantages of the method are: the precipitant, dimethyl oxalate, need not be added incrementally as is the case with oxalic acid; the parameters are not critical; and the procedure is less involved than that of the conventional oxalic acid method. (P.C.H.)

19631 ASSOCIATION CONSTANTS OF ANIONIC-PROTACTINIUM(V) COMPLEXES. Kolarich, R. T.; Ryan, V. A.; Schuman, R. P. (Univ. of Wyoming, Laramie). J. Inorg. Nucl. Chem., 29: 783-97(Mar. 1967).

The interaction of aqueous protactinium with various monobasic acids at an ionic strength and acidity of 1.00 was investigated. This study adds to the existing information on the anionic complexing of protactinium, which was collected at an ionic strength of 3 and an acidity of 1 to 3 N. The solvent extraction method employed involves the measurement of the distribution of protactinium (Pa-233) between various aqueous solutions and a benzene phase containing the bidentate chelating agent thenoyltrifluoroacetone (TTA). (auth)

19632 THE ABSORPTION SPECTRUM OF THE URANYL ION IN PERCHLORATE MEDIA. PART II. THE EFFECTS OF HYDROLYSIS ON THE RESOLVED SPECTRAL BANDS. Bell, J. T.; Biggers, R. E. (Oak Ridge National Lab., Tenn.). J. Mol. Spectros., 22: 262-71(Mar. 1967). (ORNL-P-2378).

The uranyl ion absorption spectrum was found to become more complex throughout the visible region when the uranyl ion hydrolyzes. The visible region (3300 to 5000 Å) of the spectrum of the uranyl ion at various stages of hydrolysis was, for the first time, resolved into individual bands. Hydrolysis was found not to affect the transition frequencies observed for uranyl ion in acidic media. However, the intensities and half-band widths of all the bands were observed to increase with hydrolysis. This information supports the idea that the observed transitions involve the O−U−O bonds and that hydrolysis of the uranyl ion involves the water of hydration in the equitorial positions. Over the range of conditions studied, hydrolysis was found to have no effect on the uranyl ion structure, and evidence is given against calculating thermodynamic quantities from visible spectral data for uranyl ion hydrolysis. (auth)

19633 AMINO WAGGING AND INVERSION IN METHYLAMINES. PART II. CH_3ND_2 AND CD_3NH_2. Tsuboi, Masamichi; Hirakawa, Akiko Y.; Tamagake, Keietsu (Tokyo Univ.). J. Mol. Spectros., 22: 272-83(Mar. 1967).

Fine structure of the amino-wagging band at 625 cm^{-1} of CH_3ND_2 was reexamined, and that at 740 cm^{-1} of CD_3NH_2 was newly observed. Analysis of the spectra was made on the basis of the previously described theory for coupling of the internal rotation and inversion of the methylamine molecule. A hypothetical inversion

splitting when the coupling is absent is estimated to be 13 cm^{-1} for the first excited state of CH_3ND_2, and 18 cm^{-1} for the first excited state of CD_3NH_2. The barrier height is estimated to be 1688 cm^{-1} in the wagging-inversion double-minimum potential in CH_3NH_2. (auth)

19634 NUMBER TRANSMISSION OF FAST ELECTRONS THROUGH FINITE SLABS OF CARBON AND POLYSTYRENE. Nakai, Yohta; Matsuda, Kohji; Takagaki, Torao; Kimura, Ki-ichi. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 5-8(1965-1966). (In Japanese).

A series of the number transmission of monoenergetic electrons between 1.0 and 2.0 MeV through finite slabs of carbon and polystyrene was measured. A comparison of their extrapolated ranges and theoretical true ranges showed disagreement for carbon, but reasonable agreement for polystyrene. (auth)

19635 KINETICS OF ELECTRON EXCHANGE BETWEEN HEXACYANOFERRATE(II) AND -(III) IONS. Campion, Raymond J.; Deck, Charles F.; King, Perry Jr.; Wahl, Arthur C. (Washington Univ., St. Louis). Inorg. Chem., 6: 672-81(Apr. 1967).

The rate of isotopic exchange between $Fe(CN)_6^{4-}$ and $Fe(CN)_6^{3-}$ was measured in aqueous solutions containing a number of different electrolytes. The rate was found to be first order in the concentration of each reactant and to depend markedly on the nature and concentration of the cations present. Very little dependence was found on the anion concentration or on the ionic strength at constant cation concentration. The following values of the rate constant ($\underline{M}^{-1}$ sec^{-1}) at 0.1°C and the activation energy (kcal/mole), respectively, were determined for alkaline solutions containing 0.01$\underline{M}$ of the indicated cation: $(CH_3)_4N^+$, 1260 and 0.3; $(C_2H_5)_4N^+$, 250 and 0.6; $(n\text{-}C_3H_7)_4N^+$, 41 and 5.2; $(n\text{-}C_4H_9)_4N^+$, 23 and 5.0; $(n\text{-}C_5H_{11})_4N^+$, 16 and 7.8; $(C_6H_5)_4As^+$, 28 and 6.3; $Co(C_5H_5)_2^+$, 1050 and −1.0; K^+, 230 and 6.0. The large and specific effects of different cations was attributed to the participation of cations in the reaction by reduction of the Coulombic repulsion between the reactants in an activated complex. There was no evidence, however, that the cations participate in the actual transfer of an electron. Extrapolation to zero cation concentration gave values of 6.0$\underline{M}^{-1}$ sec^{-1} and 9.1 kcal/mole for the rate constant at 0.1° and the activation energy, respectively, for very dilute solutions. From these values the free energy and entropy of activation were calculated to be 15.6 kcal/mole and −24 cal deg^{-1} $mole^{-1}$, respectively. These values are compared with values calculated from a model based on the Marcus theory of electron transfer. (auth)

19636 ISOTOPE EFFECT ON DIFFUSION OF LITHIUM IONS IN FUSED SALTS. Aperce, Jean-Pierre; Lantelme, Frederic; Chemla, Marius (Univ., Paris, Orsay, France). Compt. Rend., Ser. C, 264: 461-4(Feb. 6, 1967). (In French).

An apparatus is described for measuring the isotope effect on the diffusion of the ions ^6Li and ^7Li in fused mixtures of KNO_3–$NaNO_3$. The mean value of this effect is 0.75% at 350°C. It increases appreciably when the temperature is decreased. (tr-auth)

19637 TECHNETIUM CHEMISTRY, OXIDATION STATES AND SPECIES. Rulfs, C. L.; Pacer, R. A.; Hirsch, R. F. (Univ. of Michigan, Ann Arbor). J. Inorg. Nucl. Chem., 29: 681-91(Mar. 1967). (COO-1483-1).

Pertechnetic and perrhenic acids behave as very strong acids K_a ~10^8. Their extensive dehydration to M_2O_7 in such media as 7$\underline{M}$ sulphuric acid complicates a spectrophotometric comparison of acid strengths. Chloroform extractable TcO_3Cl forms from pertechnetate in the presence of chloride ion and concentrated sulfuric acid. The (VII) state of this compound is confirmed and its spectrum described. No evidence of unusual technetium (VII) species, in aqueous media of 1$\underline{N}$ base to 1$\underline{N}$ acid, was found. The red color of concentrated aqueous $HTcO_4$ is ascribed to a lower (VI) or (V) state. The existence in alkaline media of a technetate, TcO_4^{2-}, species was re-examined. Some (IV) and (III) state species are partially characterized, but no Tc_2O_3 could be isolated. (auth)

19638 LANTHANIDE AND ACTINIDE SULFATE COMPLEXES. II. DETERMINATION OF THERMODYNAMIC PARAMETERS. de Carvalho, R. G.; Choppin, G. R. (Florida State Univ., Tallahassee). J. Inorg. Nucl. Chem., 29: 737-43(Mar. 1967).

A calorimetric titration technique was used to obtain the enthalpies of formation in solutions of $LnSO_4^+$ and $Ln(SO_4)_2^-$ (Ln = lanthanide ions) of 2.00 $\underline{M}$ ionic strength. Using the temperature coefficient technique for solvent extraction data, the enthalpies of formation were calculated for the sulfate complexes of Ce, Pm, Eu, Am, Cm, and Cf. The entropies were evaluated using ΔG data reported previously. The ΔH_1 values were endothermic and ranged from 3.7 (La) to 4.4 (Dy) kcal. The ΔS_1 values varied from 18.4 (La) to 20.4 (Dy) cal/deg. From these thermodynamic parameters, it was concluded that the extent of inner sphere complexation is equal to or greater than that of outer sphere ion pairing. (auth)

19639 LANTHANIDE AND ACTINIDE SULFATE COMPLEXES. I. DETERMINATION OF STABILITY CONSTANTS. de Carvalho, R. G.; Choppin, G. R. (Florida State Univ., Tallahassee). Contract AT(40-1)-1797. J. Inorg. Nucl. Chem., 29: 725-35(Mar. 1967). (ORO-1797-3).

The stability constants of the complexes of yttrium and the lanthanide ions (except Pm) with sulfate were determined using a competitive potentiometric method at μ = 2.00$\underline{M}$ ($NaClO_4$), pH = 3.0 and t = 25°C. A solvent extraction technique was used to measure stability constants of the sulfate complexes of Ce(III), Pm(III), Eu(III), Am(III), Cm(III), and Cf(III) with the same set of conditions. With these conditions there is evidence of formation of $M(SO_4)^+$ and $M(SO_4)_2^-$. The values of β_1 ranged from 12 to 27, while those of β_2 varied from 39 to 117. (auth)

19640 DECOMPOSITION OF COMPLEX FLUORIDES OF THE TYPE Me_xUF_6. Peka, I.; Vachuska, J. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 32: 426-30 (Jan. 1967).

Kinetics of the decomposition of $UF_6 \cdot$ (2.2 to 2.5)NaF, $K_2(UF_8)$, and $Cs_2(UF_8)$ were studied using differential thermal and thermogravimetric analyses. Attempts to prepare complexes of lithium fluoride and uranium hexafluoride were unsuccessful. Results indicated that KF and CsF complexes were the most stable. Reaction orders and activation energies were calculated. (J.G.B.)

19641 URANYL COMPLEXES WITH PHENOLIC LIGANDS. VII. POTENTIOMETRIC INVESTIGATION OF URANYL COMPLEXES WITH SALICYLIC 5-SULFOSALICYLIC, 3,5-DINITROSALICYLIC, AND GALLIC ACID. Bartusek, M. (Univ., Brno). Collect. Czech. Chem. Commun., 32: 116-29(Jan. 1967). (In German).

By potentiometric investigation of very dilute solutions of uranyl salts, the formation of yellowish brown soluble MR and MR_2 complexes with salicylic, sulfosalicylic, and dinitrosalicylic acid and MR_2H complexes with salicylic and sulfosalicylic acid was detected. These ligands formed no complexes with component ratios M : R equal 1 : 3 at C_R below 0.1$\underline{M}$. Gallic acid formed a mixture of one- and many-nuclei complexes. (tr-auth)

19642 INFRARED SPECTRA OF THENOYLTRIFLUOROACETONE (HTTA) AND ITS COMPLEXES. Ohwada, K. (Japan Atomic Energy Research Inst., Tokyo). J. Inorg. Nucl. Chem., 29: 833-6(Mar. 1967).

The ir spectra of UO_2(II), Th(IV), Cu(II), Ni(II), Fe(II), Na(I), and K(I) complexes with deuterated and normal 4,4,4-trifluoro-1-(2-thienyl)-1,3-butanedione were recorded over the range of 650 to 4000 cm^{-1}. The accuracy for determining band frequency was found to be ±2 cm^{-1} at 10 μ. The main features of the spectra of the deuterated and normal TTA were similar to that of the spectra of 2,4-pentanedione and its deuterated derivative. (P.C.H.)

19643 MOLECULAR REARRANGEMENTS. XXIII. THE MECHANISM OF HYDRIDE SHIFT DURING HYDROLYSES OF CERTAIN SUBSTITUTED NORBORNYL TOSYLATES. Collins, Clair J.; Benjamin, Ben M. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Amer. Chem. Soc., 89: 1652-61 (Mar. 29, 1967). (ORNL-P-2574).

The hydrolyses of 2-exo-hydroxy-2-phenyl-3-exo-tosyloxynorbornane (2) and its 5,6-exo-dideuterio analog(2a) were studied. Five products were identified and found to be present in combined yields of 88 to 92%. Hydride shifts accompanying the rearrangements took place by discrete, sequential 1,2 shifts, and not through face-protonated, nortricyclonium-type ions. The products of 6,1-, 1,2-, and 6,2-hydride (or deuteride) shifts were identified. The formation of 5-deuterio-3-phenylnortricyclenol-3 (4a) takes place with stereospecific loss of the 5-exo-deuterium of 2a. Confirmatory experiments with tosylate containing an endo-3-deuterium and with 7-phenyl-7-syn-hydroxy-2-norbornyl tosylate (14) and its 5,6-endo-dideuterio analog 14a were also performed. Tosylates 2 and 14, upon hydrolysis, produced yields which were identical within experimental error. Tosylates 2 and 2a gave different yields of the products, in a direction which was in accord with the anticipated hydrogen–deuterium isotope effect. (auth)

19644 KINETICS OF REDUCTION OF AZOBENZENES BY A HYDROQUINONE. Reeves, R. L.; Andrus, R. W. (Eastman Kodak Co., Rochester, N. Y.). J. Amer. Chem. Soc., 89: 1715-21(Mar. 29, 1967).

The kinetics of reduction of para-substituted azobenzenesulfonates by 9,10-anthracenediol-2-sulfonate were measured in aqueous solution by a stopped-flow method. Substrates with electron-donating substituents were reduced to the aniline stage, whereas those with electron-withdrawing substituents were only reduced to the hydrazobenzene stage. The variation of the experimental second-order rate constant with acidity in the region H_0 0.0 to pH 7.5 indicates a rate law, $k_2 = k_0 + k_H a_{H^+} + k_B / a_{H^+}$. The acid-catalyzed reduction involves reaction between protonated azoben-

zene and un-ionized hydroquinone; the pH-independent reduction involves reaction between unprotonated azobenzene and un-ionized hydroquinone; and the base-catalyzed reaction involves unprotonated azobenzene and un-ionized hydroquinone; and the base-catalyzed reaction involves unprotonated azobenzene and ionized hydroquinone. A general acid-catalyzed path was observed with substrates having electron-withdrawing substituents, the extent of which increased with the electron-withdrawing power of the substituent. The constants k_0, k_H, and k_B did not vary greatly with structure and gave nonlinear, free energy relations. The effect of structure on k_H is due to opposing effects on the K_a's ($\rho^+ = +2.3$) and on the specific rate constants for reduction of the protonated azobenzenes ($\rho = +2.8$). Arrhenius plots of k_0 showed isokinetic points in the temperature range 33 to 50°. The variation in k_0 with structure is due to large differences in $\Delta H^{\ddagger}$ and in $\Delta S^{\ddagger}$. A kinetic deuterium isotope effect is found for the pH-independent reduction of one substrate ($k_0^H/k_0^D = 2.7$). The results are discussed in terms of possible electron-transfer mechanisms. (auth)

19645 γ-DEUTERIUM ISOTOPE EFFECTS ON THE SOLVOLYSES OF NORBORNYL BROSYLATES. Murr, B. L.; Nickon, A.; Swartz, T. D.; Werstiuk, N. H. (John Hopkins Univ., Baltimore). J. Amer. Chem. Soc., 89: 1730-2(Mar. 29, 1967).

The average kinetic isotope effects through three half-lives on the solvolysis of exo-norbornyl-6-exo-d brosylate (6-exo-d-I), exo-norbornyl-6-endo-d brosylate (6-endo-d-I), endo-norbornyl-6-exo-d brosylate (6-exo-d-II), and endo-norbornyl-6-endo-d brosylate (6-endo-d-II) in acetic acid–potassium acetate and in 80% aqueous ethanol were measured. Analysis of the data revealed an appreciable isotope effect ($k_H/k_D = 1.10 \pm 0.02$) for D at C-6 on the solvolysis of 6-exo-d-I and 6-endo-d-I but a negligible or slightly inverse isotope effect (0.99 ± 0.02) for D at C-6 on the solvolysis of 6-exo-d-II and 6-endo-d-II. (J.G.B.)

19646 SECONDARY DEUTERIUM KINETIC ISOTOPE EFFECTS IN ACETOLYSIS OF 2-NORBORNYL-6-d BROSYLATES. Jerkunica, Josko M.; Borcic, Stanko; Sunko, Dionis E. (Institute Rudjer Boskovic, Zagreb). J. Amer. Chem. Soc., 89: 1732-4 (Mar. 29, 1967).

Studies were made on the acetolysis of two deuterated endo-2-norbornyl brosylates and two deuterated exo-2-norbornyl brosylates. Results indicated that the acetolyses of both endo compounds proceeded without a significant kinetic isotope effect and that the acetolyses of both exo compounds exhibited similar isotope effects. Rate constants are tabulated. (J.G.B.)

19647 DEUTERIUM EXCHANGE OF 4-PYRIMIDONES AND 4-PYRIMIDTHIONES. I. Wright, George E.; Bauer, Ludwig; Bell, Charles L. (Univ. of Illinois, Chicago). J. Heterocycl. Chem., 3: 440-3(Dec. 1966).

The H-D exchange of H-2 in 4-pyrimidone, some 1- and 3-alkyl-4-pyrimidones, and several of their thione analogs in D_2O at moderate temperatures is reported. This reaction is apparently not susceptible to acid or base catalysis. Cations of the 4-pyrimidones were found not to exchange H-2 at all in acid media. Catalytic amounts of bases did not alter the exchange rates whereas more concentrated alkali decomposed the pyrimidone. However, 1,4(3,4)-dihydro-1,3-dimethyl-4-oxopyrimidinium iodide (and its 6-methyl analog) exchanged H-2 rapidly in neutral D_2O, almost instantly when triethylamine was added as a catalyst, and very slowly in dilute solutions of DCl in D_2O. Mechanisms are proposed to account for these phenomena involving only the free base and D_2O. The rates of exchange of 4-pyrimidone were determined at 70, 80, and 90°C and found to be 0.283, 0.90 and 1.91×10^{-4} sec^{-1}, respectively. From these values an activation energy of 23.7 kcal/mole was calculated. Calculations using absolute rate theory gave an entropy of activation of −12.4 cal/deg. A highly ordered transition state is accompanied by a decrease in the entropy of the system, the amount of which was found to be consistent with a 4-center transition state for the exchange. (BBB)

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Refer also to abstracts 19720, 20549, 21711–21715, 21717, 21720, 21723, 21724, and 21803.

19648 (BMwF-FBK-66-45) MESSUNGEN ZUR BEVORZUGTEN REKOMBINATION VON IONEN IN GASEN UND FLUESSIGKEITEN. (Studies on Preferential Recombination of Ions in Gases and Fluids). Koepp, R. (Goettingen Univ. (West Germany). Institut fuer Medizinische Physik und Biophysik). Dec. 1966. 11p. (In German). Dep. mn.

Attempts were made to prove preferential recombination in x irradiated gases under high pressures, and to correlate the results received with fluids. It was observed that in oxygen with a pressure of 15 atm about 10% of the ions generated by x irradiation disappear due to preferential recombination. An estimation of preferential recombination in liquid hydrocarbons gave values in agreement with the experimental data. (P.C.H.)

19649 (COO-1617-6) HALOGEN ATOM REACTIONS ACTIVATED BY RADIATIVE NEUTRON CAPTURE AND ^{82m}Br ISOMERIC TRANSITION. Progress Report No. 1, May 1966–February 1967. (Nebraska Univ., Lincoln. Dept. of Chemistry). Feb. 1967. Contract AT(11-1)-1617. 97p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: effects of moderators on the isomeric transition induced reaction of ^{82}Br with methane; nature of (n,γ) and (I.T.)-activated Br reactions in liquid isomers of hexane; effects of molecular parameters on the ^{79}Br(n,γ)^{80m}Br and the ^{82m}Br(I.T.)^{82}Br processes in liquid hydrocarbons; isomeric transition induced reactions of ^{130}I in cyclohexane; and reactions of I_2 activated by the (I.T.) and (n,γ) processes transition in chloromethanes. (P.C.H.)

19650 (AD-628301) INVESTIGATION OF THE ROLE OF FREE RADICALS IN THE ACETALDEHYDE POLYMERIZATION PROCESS IN THE SOLID PHASE UNDER γ IRRADIATION. Pshezetskii, V. S.; Tupikov, V. I. Translated from Vysokomol. Soedin., 213-19(1963). 14p. (FTD-TT-65-978). CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The EPR method was used to investigate the processes of formation and recombination of the radicals that form in crystalline acetaldehyde under γ irradiation. It was established that in the dose range from 0.1 to 10 MRAD, the radical concentration corresponds in order of magnitude to the concentration of polymer chains. Radical recombination takes place abruptly at temperatures coinciding with the "critical" temperatures determined by the thermography method. Monomolecular rupture takes place at small radiation doses; at larger doses (0.2 MRAD and up), chain rupture takes place in accordance with a bimolecular law. UV radiation initiates polymerization of crystalline acetaldehyde. The nature of the radicals that appear corresponds perfectly to that of the radicals formed on exposure to γ radiation; the concentration of the radicals corresponds to that of the molecular chains. The results obtained justify the assumption that polymerization of crystalline acetaldehyde proceeds by the radical mechanism when initiated by either ionizing radiation or ultraviolet light. (auth)

19651 RADIOCHEMICAL COPOLYMERIZATION OF STYRENE WITH ACRYLONITRILE IN THE CRYSTALLINE PHASE. Chapiro, Adolphe; Cordier, Pierre (CNRS, Bellevue, France). J. Chim. Phys., 64: 334-7(Feb. 1967). (In French).

The radioinduced copolymerization of solid mixtures of styrene (St) and acrylonitrile (AN) was studied at −94°C. When AN was gradually added to St, the rate of conversion increased linearly up to the composition of the eutectic mixture (85% AN) and therefore it rose more rapidly. The results can be interpreted by assuming that the reactions occur simultaneously and independently in the eutectic, leading to a copolymer containing 10 to 12% St, and in the pure AN crystals leading to polyacrylonitrile. (auth)

19652 INFLUENCE OF SOME ADDITIVES ON THE RADIOCHEMICAL POLYMERIZATION OF SOLID ACRYLONITRILE. Chapiro, Adolphe; Inoue, Miyako (CNRS, Bellevue, France). J. Chim. Phys., 64: 338-46(Feb. 1967). (In French).

The polymerization of crystalline acrylonitrile, initiated by 45 kV x rays, was investigated over a broad temperature range in the presence of several additives: benzoquinone, CCl_4, acetone, etc. All additives reduced the rate of polymerization but the largest effect was observed with acetone. The molecular weight of the polyacrylonitrile arising in the reaction was not affected by the presence of either benzoquinone or iodine, it was slightly reduced by CCl_4 and more significantly by methanol and acetone. During the post-polymerization observed with pure acrylonitrile new growing chains arose. Benzoquinone and CCl_4 inhibited the initiation of these new chains but did not prevent the growing of existing active chains; acetone completely inhibited the post-polymerization. The break on the Arrhenius diagram at −140°C appeared on the molecular weight diagram, but the rates of initiation, derived from the ratio conversion/M_n did not exhibit any anomaly at −140°C. It thus appears that the phase transition, which is responsible for this discontinuity, affects chain propagation but not chain initiation. A new discontinuity on the Arrhenius diagram was found at −180°C, the rates suddenly dropped below this temperature, whereas molecular weights rose. A strong luminescence was observed in the same temperature range, when warming the irradiated mixtures acrylonitrile–acetone to room temperature. It is believed that the new perturbation occurring below −180°C is caused by the trapping of electrons and this supports the assumption of the ionic nature of this polymerization. (auth)

19653 RADIATIVE CHLORINATION OF PHENYLMETHYLDICHLOROSILANE AND PHENYLTRICHLOROSILANE. Filippov, M. T.; Dzhagatspanyan, R. V.; Motsarev, G. V.; Rozenberg,

V. R.; Zetkin, V. I. Zh. Obshch. Khim., 37: 267-71(Jan. 1967). (In Russian).

The singularities of ^{60}Co γ-induced chlorination of phenyltrichlorosilane and phenylmethyldichlorosilane at 0 to 150°C were analyzed. Radio-chlorination of phenylmethyldichlorosilane and phenyltrichlorosilane at 0°C was similar to the photochemical and to the chlorination-forming products of chlorine attachment to the aromatic nucleus; while at 100°C and over replacements in aromatic nucleus formed the product. Certain features of radiation displacement at 100 to 150°C were not in agreement with the concepts of the radical-reaction mechanisms. The linear dependence of the rate of phenylmethyldichlorosilane chlorination on the dose and the absence of inhibiting oxygen effects represent such peculiarities. (R.V.J.)

19654 RADIOLYSIS OF LIQUID ACETONITRILE. Bradley, D.; Wilkinson, J. (Royal Coll. of Advanced Tech., Salford, Eng.). J. Chem. Soc. (A), No. 4, 531-7(1967).

Liquid acetonitrile was irradiated with ^{60}Co γ rays, 250 kVp x rays, and 4 MeV electrons. The major products were hydrogen, methane, succinonitrile, and a solid substance. The effects of total dose, dose rate, and the presence of free radical scavengers were investigated. Mechanisms for the formation of the radiolysis products are discussed. (auth)

19655 THE HYDRATED ELECTRON. Walker, D. C. (Univ. of British Columbia, Vancouver). Quart. Rev. (London), 21: No. 1, 79-108(1967).

The subject is reviewed under the following headings: introduction (electrons solvated in various media, methods of producing e^-_{aq}); chemical evidence for e^-_{aq} (competition studies, effect of ionic strength); spectroscopic evidence for e^-_{aq} (technique of pulse radiolysis, absorption spectrum of e^-_{aq}, identification of absorption band); reactivity of e^-_{aq} (reactions in irradiated water, lifetime of e^-_{aq} in water, reactivity with solutes); structure of e^-_{aq} (electron binding in various media, Jortner's model for e^-_{aq}, alternative models, trapped and solvated electrons); and conclusions. (UK)

19656 HIGH-PRESSURE REACTIONS. II. γ-RAY POLYMERIZATION OF ACRYLAMIDE. Prince, M.; Hornyak, J. (New York Univ., University Heights). J. Polym. Sci., Pt. A-1, 5: 531-6(Mar. 1967).

The post-irradiation effect of high pressure on the gamma-initiated solid-state polymerization of acrylamide is described. Polymer conversion was found to increase significantly with applied pressure. The molecular weight of polymer increased with pressure. (auth)

19657 URANYL ION-SENSITIZED POLYMERIZATION OF ACRYLAMIDE AND METHACRYLAMIDE IN AQUEOUS SOLUTION. Venkatarao, K.; Santappa, M. (Univ. of Madras). J. Polym. Sci., Pt. A-1, 5: 637-49(Mar. 1967).

The kinetics of polymerization of the vinyl monomers, acrylamide and methacrylamide, photosensitized by uranyl ions in homogeneous aqueous acid medium was studied systematically. Monochromatic radiation of wavelengths 365, 405, and 436 mμ was used for irradiation. Uranyl perchlorate in aqueous perchloric acid (pH = 0 to 2) was used as the sensitizer to ensure that only uncomplexed UO_2^{2+} ions existed in the solution. Polymerization was found to proceed without any induction period, the steady state being attained in about 10 to 20 min., and was followed by the measurement of the rate of monomer disappearance by bromine addition method. The chain lengths of the polymers were determined by viscometry. It was observed that there was no change in the initiator concentration, $[UO_2^{2+}]$, during polymerization. The dependence of the rate of polymerization on variables like light intensity, light absorption fraction by the active species, wavelength, monomer concentration, hydrogen ion concentration, temperature, nature of the acid used ($HClO_4$ and H_2SO_4), viscosity of the medium etc., was studied. A kinetic reaction scheme is proposed and discussed in the light of the experimental results. Certain rate parameters were calculated. The mechanism of photosensitization by uranyl ions with specific reference to primary photochemical act, initiation of polymerization etc., is discussed. (auth)

19658 ELECTRON AND γ-RAY INDUCED ADDITION OF ACETONITRILE TO OLEFINS. Rokach, J.; Krauch, C. H. (Max-Planck-Institut fuer Kohlenforschung, Muelheim, Ger.). Naturwissenschaften, 54: 166-7(1967).

The electron and gamma-induced reaction of acetonitrile with olefins was studied. Because of radical stabilities and the influence of steric factors, only anti-Markownikoff products were obtained. After irradiation with electrons, succinonitrile was isolated indicating the participation of the CH_2CN radical in the radiation chemical reaction. Linear energy transfer effects presumably are of importance in the electron irradiation experiments as succinonitrile was formed with high dose rates. There was no formation of succinonitrile when gamma irradiation was applied. The olefins used, the products, the chemical yield, and G-values are given. (D.H.M.)

19659 CYCLO- AND CYCLIZED DIENE POLYMERS. XIII. γ-RAY-INITIATED POLYMERIZATION OF 1,3-DIENES. Stepan, Vaclav (Inst. of Physical Chemistry, Prague); Vodehnal, Josef; Koessler, Ivo; Gaylord, Norman G. J. Polym. Sci., Pt. A-1, 5: 503-9(Mar. 1967).

The gamma-initiated polymerization of butadiene, isoprene, and 2,3-dimethylbutadiene-1,3 was carried out at 20°C and −78°C. Polymers of butadiene and isoprene with mixed linear and cyclic structure were proved to result from the polymerization at −78°C. A monocyclic structure was found for the 2,3-dimethylbutadiene-1,3 polymers initiated either at −78°C or in the thiourea canal complex at 20°C. (auth)

19660 GRAFT COPOLYMERIZATIONS OF GASEOUS VINYL CHLORIDE AND VINYLIDENE CHLORIDE ON PREIRRADIATED POLYPROPYLENE. Hayakawa, Kiyoshi; Kawase, Kaoru (Government Industrial Research Inst., Nagoya Japan). J. Polym. Sci., Pt. A-1, 5: 439-54(Mar. 1967).

The graft copolymerizations onto the preirradiated polypropylene fibers of gaseous vinyl chloride and of gaseous vinylidene chloride were carried out. The fibers were preirradiated with γ rays from a ^{60}Co source at −78°C in air to a total dose of 8×10^5 RAD, and were thus presumed to contain peroxide radicals, which were active in grafting at ordinary temperature. The volume decrease of monomers at constant pressures due to the sorption and the grafting reaction was followed automatically at temperatures ranging from −10 to 80°C. The net monomer consumption through the grafting process was estimated by subtracting the volume change due to the sorption from the total volume change of monomers. In general, the extent of grafting was lower at the higher grafting temperature and the decrease of the grafting activity of fibers was also accelerated. The grafting was found to increase almost linearly with the logarithm of the reaction time and the logarithm of the radiation dose to the fibers. The extent of grafting was also proportional to the vapor pressure of monomer at a given reaction temperature and was supposed to be controlled by the amount of the monomer adsorbed. Raising the irradiation temperature higher than 0°C brought about a marked decrease in the activity of preirradiated polypropylene. The grafting activity was successfully retained by the polymer for at least a fortnight at −78°C. (auth)

19661 FORMATION OF HIGH BOILING PRODUCTS OF RADIOLYSIS BY RADIATION MIXTURES OF PERFLUOROBENZENE WITH PERFLUOROCYCLOHEXANE AND PERFLUORONONAN. Khramchenkov, V. A. At. Energ. (USSR), 21: 375-8(Nov. 1966). (In Russian).

The dependence of the formation of polymer products during the (n,γ) irradiation of mixtures of hexafluorobenzene with perfluorocyclohexane and n-perfluorononane on the concentration of the hexafluorobenzene was determined. A hypothesis on the inhibiting effect of hexafluorobenzene during the radiolysis of perfluorocyclohexane was proposed. It was established that during the radiolysis of n-perfluorononane, hexafluorobenzene plays the role of an agent initiating polymerization. (tr-auth)

19662 EFFECT OF NAPHTHALENE AND DIPHENYL ON RADIATION POLYMERIZATION OF METHYL METHACRYLATE IN SOLUTION. Czajkowski, J.; Turska, E.; Kroh, J. (Technical Univ., Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 14: 861-4(1966).

The effects of naphthalene and biphenyl on the polymerization of methyl methacrylate(MM) in acetone were studied. In the presence of naphthalene a significant change of the molecular weight of the polymer of MM was observed. When the concentration of naphthalene equalled 2 moles/l, the molecular weight rose by about 90%. Biphenyl caused no significant increase in molecular weight. Additional experiments were carried out to compare the shielding action of naphthalene and biphenyl with that of benzene in acetone and pyridine solutions of MM. (J.G.B.)

19663 RADIOLYSIS OF AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID. Bugaenko, L. T.; Moralev, V. M. (Moscow State Univ.). Zh. Neorg. Khim., 11: 838-44(Apr. 1966). (In Russian).

It was shown that under the effect of ionizing radiation on concentrated hydrochloric acid solutions, molecular Cl_2 appears with the basic conversion products of the chloride ion. The dependence of the yield of Cl_2 on the concentration of the hydrochloric acid in saturated nitric acid was investigated. It was found that the Cl_2 yield in 6M HCl = 1.2 molecules/100 eV. Investigation of the radiolysis of 6M solutions of HCl, saturated with O_2, showed that the Cl_2 yield in these conditions increased to 4.4M and the secondary

product of the oxidation of Cl_2, chlorine dioxide, appeared. A mechanism for the radiation-chemical conversion of chloride ions in concentrated hydrochloric acid solutions, taking into consideration both the indirect and direct effects of irradiation on chloride ions, is proposed. (tr-auth)

19664 PULSE RADIOLYSIS OF HYDROGEN SULFIDE IN AQUEOUS SOLUTIONS. Karmann, W.; Meissner, G.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 22b: 273-82(Mar. 1967). (In German).

The reactions of the OH radical with H_2S and $SH^\ominus$ are very fast ($k = 1.1 \times 10^{10}$ and 5.4×10^9 mole^{-1} liter sec^{-1}, respectively). The hydrated electron reacts with H_2S ($1.1 \cdot 10^{10}$) but does not react with $SH^\ominus$. The rate constant of the reaction $CNS + SH^\ominus \rightarrow CNS^\ominus + SH$ was found to be equal to 9.8×10^8. Species absorbing at 3800 Å ($\epsilon \sim 10^4$ mole^{-1} liter cm^{-1}) are formed in these reactions of H_2S and $SH^\ominus$. The intensity of this absorption is very low in strongly acid solutions, increases with pH, goes through a broad maximum at about pH = 7, reaches a lower plateau between pH = 8.5 and 10.5 and decreases in strongly alkaline solutions. At pH values below 7, the intensity is dependent on the concentrations of both $SH^\ominus$ and free H_2S, i.e., at constant $SH^\ominus$ concentration a stronger absorption occurs if more free H_2S is present. In the plateau below pH = 8.5 to 10.5, the intensity is practically independent of the $SH^\ominus$ concentration above 4×10^{-5} mole/l. The decay of the 3800 Å absorption after the pulse is first order with $\tau_{\frac{1}{2}} = 5$ μsec independent of the $OH^\ominus$ and $SH^\ominus$ concentrations in alkaline solutions. Below pH = 7, the absorption disappears by second order, the rate constant being larger at lower pH values. SH or $S^\ominus$ absorb weakly in the near UV and do not contribute to the 3800 Å absorption. This absorption is attributed to the ions $H_2S_2^\ominus$ or $H_2S^{2\ominus}$ in alkali and to $H_2S_2^\ominus$ or higher complexes such as $H_3S_3^\ominus$ in acid. The first order decay of 5 μsec is attributed to the spontaneous decomposition of $S_2H^{2\ominus}$ into $S^\ominus$ + $SH^\ominus$. Two $S^\ominus$ ions form $S_2^{\ominus}$ ($2k = 5 \cdot 10^9$ mole^{-1} liter sec^{-1}). The complex $H_2S_2^\ominus$ is formed in the fast reaction $SH + SH^\ominus \longleftrightarrow S_2H_2^\ominus$ (dissociation constant about $4 \cdot 10^{-5}$ mole/l). The formation of an intermediate complex $SHOH^\ominus$ in the reaction of OH with $SH^\ominus$ is discussed. This intermediate reacts with either $SH^\ominus$ to form $S_2H^{2\ominus}$ or with $OH^\ominus$ (or other proton acceptors such as $HPO_4^{2\ominus}$) to form $S^\ominus$ + $H_2O + OH^\ominus$. (auth)

19665 HYDROGEN FORMATION IN THE γ RADIOLYSIS OF CYCLOHEXANE–THIOPHENOL-d_1 MIXTURES. Bergdolt, A.; Schulte-Frohlinde, D. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 22b: 270-3(Mar. 1967). (In German).

The G-values for hydrogen formation from mixtures of cyclohexane with thiophenol and thiophenol-d, were determined. The hydrogen yield was not essentially reduced by the addition of thiophenol. This behavior is in contrast to the effects of other aromatic compounds and is caused by the lability of the S–H bond. By deuteration of the thiophenol in the S–H group it could be determined that a large part of the hydrogen formed originated from the S–H group. These results allow a quantitative evaluation of ionic processes in the hydrogen formation. (tr-auth)

19666 ELECTRON SPIN RESONANCE OF X-IRRADIATED SINGLE CRYSTALS OF HYDROXYUREA. Shields, Howard W.; Hamrick, Phillip J. Jr.; Redwine, Welby (Wake Forest Coll., Winston-Salem, N. C.). Contract AT(40-1)-2835. J. Chem. Phys., 46: 2510-14(Apr. 1, 1967). (ORO–2835-8).

The electron spin resonance of x-irradiated single crystals of hydroxyurea were observed and analyzed for different orientations of the crystal in the magnetic field. The free radical responsible for the resonance was identified as $NH_2\dot{C}ONH$, and the measurements indicate that 41% of the unpaired electron is localized in the 2p orbital of the nitrogen atom. Principal values for the hyperfine coupling constants in gauss are –21.2, –13.5, and –1.5 for H, and 22.5, 1.5, and 1.2 for N. On the basis of these measurements the induced isotropic hyperfine constants for an electron entirely localized in a 2p orbital of the nitrogen atom in the $R-\dot{N}-H$ radical would be 20.2 G for nitrogen and –31 G for hydrogen. The principal g values are 2.0027, 2.0062, and 2.0108. The results indicate that the trapped radical retains the approximate orientation of the parent molecule in the lattice and that the radical is planar. (auth)

19667 PULSE RADIOLYSIS STUDIES. X. ELECTRON TRANSFER REACTIONS OF AROMATIC MOLECULES IN SOLUTION. Arai, Shigeyoshi; Grev, D. A.; Dorfman, Leon M. (Ohio State Univ., Columbus). J. Chem. Phys., 46: 2572-8(Apr. 1, 1967).

Absolute rate constants were determined by the pulse radiolysis method for electron transfer from a series of aromatic anion radicals in an isopropanol solution to a variety of different aromatic molecules: $arene_a^- + arene_b = arene_a + arene_b^-$. Nine donor-acceptor pairs were investigated in which the donor anion was diphenylide, p-terphenylide, m-terphenylide, and o-terphenylide, and the acceptor molecule was naphthalene, phenanthrene, p-terphenyl, pyrene, and anthracene. Several, but not all, of the reactions appeared to be diffusion controlled with electron transfer rate constants ranging from 2.6×10^8 to 6.4×10^9 $\underline{M}^{-1} \cdot sec^{-1}$ at 25°C. (auth)

19668 ESR STUDY ON IRRADIATED PYRIDINE: EFFECT OF IODINE ADDITION. Tsuji, Kozo; Yoshida, Hiroshi; Hayashi, Koichiro (Kyoto Univ.). J. Chem. Phys., 46: 2808-10(Apr. 1, 1967).

When pyridine was irradiated at –196°C, the main free radical formed was the cation radical. The G value for the formation of the cation radical was 0.5. The addition of iodine to pyridine caused a large increase in G value to as high as 13. The high G value is interpreted as due to the fact that the cation radical is produced through the excited state of the charge-transfer complex of pyridine with iodine. (auth)

19669 KINETICS OF POSITIVE-CHARGE AND ELECTRON SCAVENGING AND THE KINETICS OF CHARGE NEUTRALIZATION IN THE RADIOLYSIS OF DIELECTRIC LIQUIDS. Freeman, Gordon R. (Univ. of Alberta, Edmonton). J. Chem. Phys., 46: 2822-30(Apr. 1, 1967).

The kinetics of the scavenging of positive and negative species in spurs during the radiolysis of liquids is described. The motions of positive ions, solvated electrons, and scavenger molecules are simultaneously taken into consideration. The kinetic equation contains two adjustable parameters, β and f, but in most instances f is taken as unity. The theory is tested, with moderate success, against previously published results of studies of positive-ion and electron scavenging in cyclohexane and n-hexane. The recently observed complexity of the kinetics of ion-neutralization reactions in liquid cyclohexane, after a pulse of radiation, is explained in terms of the same model as that used in the scavenging kinetics. It was concluded from the over-all success of the theory that solvated electrons form in suitable nonpolar molecular liquids, such as alkanes, during radiolysis. The terms "thermal electron" and "spur" are not used by all authors to mean the same things, so they are discussed in the appendixes. The quasifree, trapped, and solvated states of electrons are distinguished in Appendix A. A definition of the term "spur" is offered in Appendix B. (auth)

19670 ESR OF FREE-RADICAL CONVERSION IN GAMMA-IRRADIATED DIHYDROTHYMINE. Bernhard, William; Snipes, Wallace (Pennsylvania State Univ., University Park). J. Chem. Phys., 46: 2848-9(Apr. 1, 1967).

Two different radical species are formed when 5,6-dihydrothymine is exposed to gamma rays. On storage at room temperature, the spectrum of irradiated 5,6-dihydrothymine changed from that due to a mixture of 5-thymyl and 6-thymyl radicals to that due to 5-thymyl alone. An activation energy of 23.1 ± 0.6 kcal/mole and a frequency factor of $(1.2 \pm 0.9) \times 10^{12}$/min for the radical conversion process were found. (M.C.G.)

19671 ESR OF RADICAL PAIRS IN IRRADIATED POLYMERS. THE ΔM = 2 TRANSITIONS. Iwasaki, Machio; Ichikawa, Takahisa (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys., 46: 2851-2(Apr. 1, 1967).

The absorption for the ΔM = 2 transition for a number of polymers irradiated by ^{60}Co γ rays at 77°K was observed. Typical spectra of the ΔM = 2 transition observed at $g \approx 4$ for irradiated polyethylene and polyoxymethylene are shown. The ΔM = 2 signals disappeared when the polymers were warmed to room temperature. (M.C.G.)

19672 ESR STUDY ON THE PHOTOINDUCED ISOMERIZATION OF THE TERT- TO ISOBUTYL RADICAL IN γ-IRRADIATED ISOBUTYL BROMIDE. Iwasaki, Machio; Toriyama, Kazumi (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys., 46: 2852-3(Apr. 1, 1967).

It was found that the tert-butyl radical formed in irradiated isobutyl bromide was isomerized into the isobutyl radical by the subsequent exposure to ultraviolet light at 77°K. Isobutyl bromide was irradiated by ^{60}Co γ rays at 77°K. It was shown that these iso- and tert-butyl radicals can be isomerized reversibly by thermal or photochemical processes. (M.C.G.)

19673 ENERGY TRANSFER FROM HIGH-LYING EXCITED STATES. Oster, Gisela K.; Kallmann, H. (New York Univ.). J. Chim. Phys., 64: 28-32(Jan. 1967).

It was found that in the benzene–$CHCl_3$ system the G value for radical formation due to energy transfer is approximately 10. It was shown that the G value for direct formation of the lowest excited singlet state of benzene S_1 is 0.2 and the G value for overall formation os S_1 is approximately 1.0. Since the G value for formation of free charges in benzene and in anthracene is 0.07 and 0.25, respectively, it is concluded that in the benzene–$CHCl_3$ system free radicals are formed by energy transfer from upper excited states of benzene. Energy from high-lying benzene states was also transferred to phenylbiphenyl oxadiazole (PBD), as evidenced by the reduction of free radical formation when PBD was added to the system benzene–$CHCl_3$ under high energy excitation. The energy

transfer from high-lying benzene states to PBD led to the formation of high-lying PBD states which can also transfer to CHCl to form free radicals, but to a smaller extent than the high-lying benzene states. This is evidenced by the quenching of PBD fluorescence by $CHCl_3$. Two types of dissociation processes were found, one in which energy is transferred to the dissociating molecule and this dissociates instantaneously and another one in which after energy transfer to the dissociating molecule an excited state of finite lifetime is formed which eventually can dissociate. The first process occurs in CCl_4 and $CHCl_3$, the latter in chlorobenzene when excited via the lowest excited benzene state or directly with ultraviolet light. Under high energy excitation, energy transfer from high-lying benzene states occurs to high-lying chlorobenzene states and these dissociate instantaneously. The lowest state with finite lifetime is subject to quenching by PBD, the higher states are not. (auth)

19674 PARAMAGNETIC RESONANCE AND ELECTRON NUCLEAR DOUBLE RESONANCE OF SUBSTITUTIONAL HYDROGEN ATOMS IN CaF_2. Bessent, R. G.; Hayes, W.; Hodby, J. W. (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 297: 376-96 (Mar. 7, 1967).

Recent infrared measurements showed that hydrogen dissolves in CaF_2 as H^- ions in fluorine sites. X irradiation of CaF_2 : H crystals at room temperature produced paramagnetic hydrogen atoms in interstitial sites. A study showed that x irradiation of CaF_2 : H crystals at 77°K produced hydrogen atoms in fluorine sites. These substitutional hydrogen atoms move into interstitial sites at 135°K giving rise to the EPR spectrum observed in room temperature irradiated crystals. A detailed description of the EPR and endor spectrum of the substitutional atoms in CaF_2 is given. It was found that the hyperfine interactions with second shell fluorines are smaller than with third and fourth shell fluorines and an explanation is suggested for this effect. Endor measurements of first shell fluorines show a resolved structure due to indirect fluorine–fluorine interactions. The endor measurements are of interest in connexion with the production and annealing mechanisms of the irradiation-induced defects. (auth)

19675 CHEMICAL EVIDENCE FOR MAIN-CHAIN SCISSION AS A MAJOR DECOMPOSITION MODE IN THE RADIOLYSIS OF SOLID PEPTIDES. Garrison, Warren M.; Jayko, Michael E.; Weeks, Boyd M.; Sokol, Harvey A.; Bennett-Cornier, Winifred (Univ. of California, Berkeley). Contract W-7405-eng-48. J. Phys. Chem., 71: 1546-7(Apr. 1967). (UCRL-17307).

A study of the gamma radiolysis of solid peptides showed that a major chemical effect was the formation of labile "amide-like" products, which are readily degraded to yield ammonia on mild hydrolysis. A study of the reaction products for N-acetylalanine was made to obtain evidence as to the mechanism of the radioinduced degradation. Main-chain scission occurred and two possible reaction schemes are given. (D.H.M.)

19676 ROLE OF IONS IN CARBON–CARBON BOND FORMATION IN HYDROCARBON RADIOLYSIS. Wagner, C. D.; Geymer, D. O. (Shell Development Co., Emeryville, Calif.). J. Phys. Chem., 71: 1551-2(Apr. 1967).

A study of the role of ions in the radiolysis of hydrocarbons showed that direct ionic dimerization of hydrocarbons is no more than a very minor reaction. The principal role of ions in such materials is believed to be as the precursor of free radicals. (D.H.M.)

19677 CARBON MONOXIDE REACTIONS. II. THE γ RADIATION INITIATED CHLOROCARBONYLATION OF PARAFFINS. Thaler, Warren A. (Esso Research and Engineering Co., Linden, N. J.). J. Amer. Chem. Soc., 89: 1902-8(Apr. 12, 1967).

The synthesis of acid chlorides by means of a radical chain reaction utilizing carbon tetrachloride and carbon monoxide as reagents was extended to include a variety of hydrocarbons. The problems encountered when peroxide initiation was used were traced to initiator-destroying products formed from the interaction of the metal reactor surface with acid chlorides. This difficulty was circumvented by using γ radiation to initiate chlorocarbonylations. The γ radiation provides the added advantage of temperature-independent initiation. Acid chlorides were produced from some representative paraffins ranging from ethane to hexadecane. Some approximate G values were determined and used to estimate the magnitude of the kinetic chain length. (auth)

19678 STUDY OF THE REVERSIBILITY OF THE RADIOLYTIC OXIDATION OF I^- IONS IN THE PRESENCE OF KH_2PO_4. Atanasiu, I. A.; Fiti, Maria (Inst. of Atomic Physics, Bucharest). Rev. Roum. Chim., 12: 297-303(Mar. 1967). (In French).

The action of ^{60}Co gamma radiation on an aqueous solution of KI was studied in the presence and in the absence of KH_2PO_4. Results give some new information concerning the radiolytic oxidation of certain anions by liberation of hydrated electrons. This reaction plays an important role in the reversibility of the radiolytic process. (tr-auth)

19679 CHEMICAL NATURE AND RETENTION OF SELENIUM RECOIL ATOMS IN NEUTRON IRRADIATED SOLID SELENIUM OXIDE. Apers, D. J.; Theyskens; Cafron, P. C. (Louvain Univ., Belg.). J. Inorg. Nucl. Chem., 29: 858-60 (Mar. 1967).

The actual retention of ^{81}Se in selenium oxide was studied by comparing the activity retained in the nonextractable fraction with the total activity, using exactly the same counting conditions. The carbon disulfide method was used since elementary Se is the only form soluble in the compound. For both isomers, ^{81m}Se and ^{81}Se, the retention values were high and reached 100% for ^{81m}Se on slow-neutron irradiations. The isomeric effect could not be vigorously demonstrated because of this high retention. (P.C.H.)

19680 THE ISOMERIC EFFECT IN SZILARD-CHALMERS RECOIL OF ^{60m}Co AND ^{60g}Co IN Co(III) COMPLEXES AS AN ADDITIVE PROPERTY OF LIGANDS. Lazzarini, E. (Centro Studi Nucleari E. Fermi, Milan). J. Inorg. Nucl. Chem., 29: 855-8 (Mar. 1967).

Studies were made on the isomeric effect in Szilard-Chalmers recoil of ^{60m}Co and ^{60g}Co formed by (n,γ) reaction in Co(III) complexes. It was concluded that the isomeric effect is essentially an additive property of the ligands which take part in the formation of the first coordination sphere of the Co(III). (P.C.H.)

19681 GAMMA RADIOLYSIS IN THE SYSTEM TOLUENE–METHYL IODIDE-^{14}C. Ronneburg, J.; Elias, H. (Technische Hochschule, Darmstadt, Ger.). Naturwissenschaften, 54: 115 (Mar. 1967). (In German).

In the γ radiolysis of the toluene–methyl iodide system, a radio-induced exchange of the methyl group was investigated by tracer techniques. No ^{14}C-containing toluene was found and it was concluded that the C–C bond between the ring and the methyl group was not broken in the radiolysis. (M.C.G.)

19682 GROWTH KINETICS OF INTERSTITIAL LOOPS IN IRRADIATED SAPPHIRE. Gulden, T. D. (Central Electricity Generating Board, Berkeley, Eng.). Phil. Mag. (8), 15: 453-67 (Mar. 1967).

The growth of interstitial dislocation loops that occurs on annealing oxygen ion-irradiated sapphire is interpreted in terms of a simple statistical model, based on the random diffusion of excess interstitial ions to existing dislocation loops. The growth of the loops is characterized by an activation energy of 1.86 ± 0.1 eV, which is thought to be that for interstitial migration of oxygen ions. It is shown that excess interstitial ions are retained in the foils for anomalously long times during annealing. This is interpreted in terms of the combined effect of a charge double layer at the surface of the platelets and anisotropy of the interstitial diffusion coefficients. Coalescence of the loops by the "self-climb" mechanism is found to be an important factor in loop growth when the loop density is high. (auth)

19683 A RADIOISOTOPE GENERATOR OF ^{113m}In. Subramanian, G.; McAfee, J. G. (State Univ. of New York, Syracuse). Int. J. Appl. Radiat. Isotop., 18: 215-21(Apr. 1967).

A method is presented for routinely eluting the 1.7-hr half-life ^{113m}In from its 118-day half-life parent ^{113}Sn. This utilizes the ion exchange properties of hydrous zirconium oxide crystals. The tin is loaded on the column in 0.3 to 0.5 N HCl solution and indium activity is eluted out with 0.1N HNO_3 or 0.1N HCl. Leakage of ^{113}Sn when eluted every day for a period of 45 days, was found to be always of the order of 10^{-5} to 10^{-6} times the original activity, and the yield of ^{113m}In ranged from 70 to 80 percent of the residual tin activity. The radiochemical impurities ^{124}Sb and ^{125m}Te present in ^{113}Sn preparations are also removed by this method. ^{113m}In obtained by this method should find numerous applications in nuclear medicine. (auth)

19684 ANNEALING EFFECTS IN NEUTRON IRRADIATED CRYSTALLINE COBALT COMPLEXES. II. HEXAMMINE AND TRIS(ETHYLENEDIAMINE)COBALT COMPLEXES. Yasukawa, T. (Tokyo Univ.). J. Inorg. Nucl. Chem., 29: 605-11(Mar. 1967).

The chemical behaviour of ^{60}Co produced by thermal neutron capture in the crystalline salts of the series $[Co(NH_3)_6]X_3$ and $[Co(en)_3]X_3$ has been investigated. The thermal recombination rates in $[Co(NH_3)_6]X_3$ depend upon X, increasing in the order nitrate, iodide, bromide, and chloride, while the apparent activation energy decreases in this order. The recombination rates increase when samples are subsequently bombarded with electrons or are annealed in a stream of ammonia. Similar results are also observed with the neutron irradiated $[Co(en)_3]X_3$. The results suggest that the diffusion of ligand molecules may play a more important role than electronic processes in annealing recombination reactions. (auth)

19685 EFFECT OF NEUTRON IRRADIATION ON THE PLASTIC BEHAVIOUR OF TYPE IIA DIAMOND PLATES. Evans, T.; Wild, R. K. (Univ. of Reading, Eng.). Phil. Mag. (8), 15: 447-51(Mar. 1967).

Type IIA diamond plates were reactor irradiated with a dose of 1.3×10^{19} nvt fast. The annealing behaviour of these plates was followed in stages from 1000 to 1800°C by measuring the infrared and ultraviolet absorption spectra. At 1800°C attempts were made to plastically deform the specimens by three-point loading. The neutron irradiation and subsequent annealing treatment increased the resistance of the diamond plates to plastic deformation. There was no evidence for any reduction in the cleavage strength of diamond at 1800°C due to the neutron irradiation and subsequent annealing. (auth)

19686 ELECTRON SPIN RESONANCE STUDY OF IRRADIATED MONOMER AND POLYMER OF 3,3-BIS(CHLOROMETHYL) OXETANE. Tsuji, Kozo; Iwamoto, Takeo; Hayashi, Koichiro; Yoshida, Hiroshi (Kyoto Univ.). J. Polym. Sci., Pt. A-1, 5: 265-72(Feb. 1967).

ESR spectra were studied for irradiated 3,3'-bis(chloromethyl) oxetane (BCMO) single crystals and poly-BCMO obtained by polymerizing BCMO single crystals in solid state. In both cases, the spectra consisted of the superposition of two-line and three-line components at −196°C. On warming the sample only the former survived. From the examination of hyperfine coupling tensors, it was concluded that the two-line spectrum is due to free radicals. For the polymer the radical is $-C(CH_2Cl)_2-CH-O-$. Orientation of the free radicals gives information about the mode of ring opening in the solid-state polymerization of BCMO. (auth)

19687 MULTIPLICATION OF COMPTON ELECTRONS IN POLYETHYLENE. Matsuda, Kohji; Nakai, Yohta; Kimura, Kiichi. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 9-15 (1965-1966). (In Japanese).

An approximate expression for the Compton current produced by absorption of gamma radiation using polyethylene sheets as dielectrics is proposed. The effects of gold and aluminum inserts on the polyethylene sheets were studied. (J.G.B.)

19688 SOME PROBLEMS ON THE GRAFTING OF FIBERS. Sakurada, Ichiro. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 17-23(1965-1966).

The application of radioinduced polymerization to the production of improved fibers is discussed. Work being done to improve the dyeability and heat resistance of synthetic fibers is reviewed. Attempts to improve the crease resistance and strength of cellulose fibers by grafting with synthetics are discussed. Other problems of radiation graft polymerization are also mentioned. (J.G.B.)

19689 SMALL-ANGLE X-RAY STUDIES ON POLYETHYLENE OBTAINED BY GAS-PHASE POLYMERIZATION OF ETHYLENE. Suzuki, Yasuo; Sakurada, Ichiro. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 25-32(1965-1966). (In Japanese).

Under an hypothesis that polymer crystals, which are formed neither from melt nor from solution but simultaneously at the formation of polymer molecule, do not exhibit regular folding of molecule, small-angle x-ray studies were carried out on polyethylene powder by radioinduced gaseous phase polymerization of ethylene at 30°C. A discrete diffraction, which indicates a long period due to regular folding of molecule was not completely absent, but was very weak. This fact may be regarded as support for the above hypothesis, because it is probable that the folding takes place to some extent at room temperature after the formation of primary crystals. (auth)

19690 OXYGEN UPTAKE DURING THE IRRADIATION OF POLYMERS IN AIR. Kimura, Fujiko; Sakurada, Ichiro. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 33-40(1965-1966). (In Japanese).

Oxygen uptake during γ irradiation was studied on polyethylene, polypropylene, polyvinyl alcohol, and cellulose. The samples were irradiated in air with ^{60}Co γ rays in sealed glass tubes. After irradiation the consumption of oxygen was measured by means of mass spectroscopy. Oxygen uptake depended upon the form of samples. The G-values of oxygen uptake in the fiber form (about 5 to 8 denier) were 37, 44, and 11 for polyethylene, polypropylene, and polyvinyl alcohol at a low dose as 1.5×10^5R. In the powder form plots of oxygen uptake against dose were linear over a wide range of irradiation dose. The G-values calculated from the slopes were 160 and 80 for polyethylene and polyvinyl alcohol, respectively. (auth)

19691 STUDIES ON POLYOXYMETHYLENE. IV. GRAFT COPOLYMERIZATION OF STYRENE ONTO POLYOXYMETHYLENE. Kimura, Fujiko; Yamauchi, Michiyo; Sakurada, Ichiro. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 41-5(1965-1966). (In Japanese).

Graft copolymerization of styrene onto Delrin and Celcon filaments were carried out at 25°C using ^{60}Co γ rays in vacuo. Methanol and N, N'-dimethylformamide were effective in accelerating the grafting. When methanol was used, the maximum grafting rate was observed at 50 to 80 vol % styrene. For grafting onto Delrin the percent graft increased with a dose to 2×10^6R and saturated at higher doses. The rate of grafting onto Celcon increased as the dose increased, and the percent graft of copolymer obtained at the dose of 5×10^6R was about 55. The grafting rate onto Celcon filament was much higher than that onto Delrin filament. (auth)

19692 STUDIES ON POLYOXYMETHYLENE. V. DEGRADATION OF STYRENE GRAFTED POLYOXYMETHYLENE. Kimura, Fujiko; Suzuki, Yasuo; Yamauchi, Michiyo; Sakurada, Ichiro. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 47-53(1965-1966). (In Japanese).

Mutual grafting of styrene onto Delrin filament was carried out at 25°C in vacuo by the use of ^{60}Co γ rays. Stabilities to heat, alkali, and acid were tested. The thermal stability of the graft copolymer was measured at 280 and 290°C in nitrogen atmosphere. There was no difference between the graft copolymer and the original Delrin filament. Stability to alkali was remarkably improved by the grafting. Delrin was almost perfectly degraded, while the graft copolymer was degraded very little by a 3 hr treatment with 10% NaOH aqueous solution at the boiling point. When hydrolysis was carried out with 10% H_2SO_4 or 10% HCl aqueous solution at the boiling point for 1 hr, the original Delrin filament was completely and the backbone (polyoxymethylene) of the graft copolymer was almost completely degraded. When the copolymer was boiled in 10% H_2SO_4 aqueous solution more than 2 hrs a part of the branch (polystyrene) of the copolymer became insoluble in benzene due to a crosslinking caused by a reaction of degradation product of polyoxymethylene on benzene rings of the branch polymer. The branch polymer was isolated by acid hydrolysis of the copolymer, and some studies on its structure were carried out by infrared spectroscopy and viscosity measurement. (auth)

19693 STUDIES ON RADIATION-INDUCED POLYMERIZATION OF α-OLEFINES. I. POLYMERIZATION OF ISOBUTENE. Ueno, Katsuji; Hayashi, Koichiro, Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 55-60(1965−1966). (In Japanese).

The radioinduced polymerization of bulk isobutene was studied under extremely anhydrous conditions. It was found that the rate of polymerization (R_p) and the molecular weights (M_n) increased with more rigorous drying of the monomer, obtaining such a high G(−m) as 2.5×10^5 and M_n as 7.3×10^6. The activation energy of R_p was nearly zero from −78° to 0°C while M_n decreased with increase in temperature. These results indicate that monomer chain transfer occurred more frequently with increase of temperature. On the other hand, the solid state polymerization of bulk isobutene at 77°K did not proceed appreciably. The glassy state polymerization of isobutene in 3-methylpentane at 77°K occurred in source, obtaining G(−m) as 3×10^2 and M_n as 1.7×10^4, which were not sensitive to drying conditions and ammonia. The structure of the polymer was completely consistent with that formed by conventional polymerization methods. (auth)

19694 STUDIES ON RADIATION-INDUCED POLYMERIZATION OF α-OLEFINES. II. POLYMERIZATION OF 3-METHYL-1-BUTENE AND 4-METHYL-1-PENTENE. Kennedy, Joseph P.; Ueno, Katsuju; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 61-9(1965−1966). (In Japanese).

The ^{60}Co gamma radioinduced polymerizations of 3-methyl-1-butene and 4-methyl-1-pentene were investigated at various temperatures in the presence of various solvents and/or ZnO. Only low molecular weight oily oligomers have been obtained. The infrared and NMR spectra of the products indicated a conventional 1, 2 enchainment in contrast to high molecular weight rearranged structures obtained under low-temperature cationic polymerization conditions. Poly(4-methyl-1-pentene) was synthesized using azobismethylpropionitrile and/or uv irradiation as typical radical initiators under various conditions. These products were virtually identical to those obtained with γ rays. The gamma radioinduced polymerization of 4-methyl-1-pentene was found to be unaffected by the presence of various ion scavengers. These facts indicate that the gamma radioinduced polymerizations of 3-methyl-1-butene and 4-methyl-1-pentene probably proceed by a free radical mechanism. (auth)

19695 STUDIES ON RADIATION-INDUCED POLYMERIZATION OF α-OLEFINES. III. COPOLYMERIZATION OF α-OLEFINES WITH SULFUR DIOXIDE. Ueno, Katsuji; Shinkawa, Akihiro; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kyokai Nempo, 7: 71-4(1965−1966). (In Japanese).

The radioinduced copolymerizations of isobutene, 3-methyl-1-butene, and 4-methyl-1-pentene with sulfur dioxide were studied.

The rates of polymerization of these α-olefins and sulfur dioxide were high. All the polymers obtained were white powders and estimated to be an alternative copolymer of α-olefins and sulfur dioxide. From ir measurements of copolymers, isomerization rearrangement seems improbable. (auth)

19696 STUDIES ON RADIATION-INDUCED IONIC POLYMERIZATION OF STYRENE. V. FREE ION MECHANISM ON POLYMERIZATION OF STYRENE. Ueno, Katsuji; Williams, Ffrancon; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 75-87(1965-1966). (In Japanese).

The radioinduced ionic polymerization of bulk styrene was studied under extremely dry conditions. It was found that the rate of polymerization, R_p, increased with more rigorous drying of the monomer. This effect was accompanied by a change in the exponent n for the dose-rate (I) dependence of R_p, from n values near unity to 0.6 ($R_p \propto I^n$). A mechanism involving biomolecular termination of free ions is thereby indicated. The strong retardation of the polymerization by scavengers of high proton affinity such as water, diethyl ether, ammonia, and trimethylamine in low concentrations (10^{-3} to 10^{-6} M) provided evidence that free cations are mainly responsible for the propagation. The addition of nitrous oxide did not affect R_p, and did not appear to prevent electron capture by styrene. By kinetic analysis in $(CN_3)_3N$ and stationary state ion concentration method k_p at 30°C was estimated to be in the range of from 10^7 to $10^9 M^{-1}$ sec^{-1}. Individual reaction steps for cationic and anionic mechanisms are discussed in detail, and the initiation is considered to occur through the respective monomeric ion radicals M^+ and M^-. It was concluded that the predominance of cationic over anionic polymerization is due to faster initiation and/or propagation processes in the former case. (auth)

19697 THE STUDY OF RADIATION-INDUCED IONIC REACTION BY ELECTRICAL CONDUCTIVITY MEASUREMENT. III. STYRENE, α-METHYLSTYRENE AND ISOBUTYL VINYL ETHER. Yamazawa, Yuzo; Takagaki, Torao; Hayashi, Kanae; Williams, Ff.; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 89-103(1965-1966). (In Japanese).

The radioinduced specific electrical conductivities, σ, of rigorously dried cyclohexane, styrene, α-methylstyrene, and isobutyl vinyl ether were measured as a function of dose rate, I. A dependence of $\sigma \propto I^n$ was observed with n between 0.50 and 0.59, depending upon the system. It was confirmed that the absolute measurements of σ for cyclohexane are consistent with G-(free ions) = 0.1 on the basis of reasonable values for the ionic mobilities. The mean lifetime τ(sec) of the ions in the stationary state was obtained directly from $\sigma(ohm^{-1}cm^{-1})$ by means of the relation $1/\tau = 3.6 \times 10^{11} \pi\sigma/\epsilon$, where ε is the dielectric constant; τ is about 50 msec at $I = 10^{15}$ $eVcm^{-3}sec^{-1}$ for the monomer systems. At the same dose rate, the σ values for styrene and α-methylstyrene were lower than for cyclohexane by a factor of about two. These results suggest that some charge carriers in the monomers have mobilities comparable to those in cyclohexane. The radioinduced conductivities of the hydrocarbon monomers were not appreciably affected by the addition of ethanol and ammonia, but were reduced by water. Some possible reasons for this behavior are discussed. (auth)

19698 RADIATION-INDUCED POLYMERIZATION BY FREE IONS. PART 3. RATE CONSTANTS FOR CATIONIC POLYMERIZATION. Williams, Ffrancon; Hayashi, Kanae; Ueno, Katsuji; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 105-18(1965-1966).

The general kinetics of radioinduced ionic polymerization are discussed and the effects resulting from impurity termination are analyzed quantitatively. A method is described for calculation of the propagation rate constants (k_p) by combining measurements of polymerization rates with conductivity determinations of the ionic lifetime in the stationary state. It was found that the rate constant for cationic propagation by free ions is $\sim 4 \times 10^6$ M^{-1} sec^{-1} for both styrene and α-methylstyrene in the bulk monomer. This large value strongly suggests that the much lower results obtained previously for styrene by the use of chemical cationic catalysts refer mainly to ion pairs of varying reactivity. (auth)

19699 TRAPPED ELECTRONS IN γ-IRRADIATED 3-METHYLPENTANE. Tsuji, Kozo; Yoshida, Hiroshi; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 119-25(1965-1966). (In Japanese).

Purified 3-methylpentane was irradiated with ^{60}Co γ rays at −196°C in the dark. A singlet spectrum was observed at the center of a six line spectrum due to 3-methylpentane radical. The singlet was very unstable, sensitive to visible light, saturated easily with microwave power; and decayed even in dark within 90 minutes after the end of irradiation. The decaying process was second order for the first 20 minutes and first order from 20 to 90 minutes after the end of irradiation. This spectrum was tentatively assigned to trapped electrons in 3-methylpentane. The ESR spectrum of CO_2^- was found to be stable, not so sensitive to visible light, and saturated somewhat with microwave power. (auth)

19700 ESR STUDY ON IRRADIATED PYRIDINE: EFFECT OF IODINE ADDITION. Tsuji, Kozo; Yoshida, Hiroshi; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 127-31(1965-1966). (In Japanese).

When pyridine was irradiated at −196°C, the main free radical formed was a cation radical, the G-value for which was 0.5. The addition of iodine to pyridine caused a large increase in G-value to as high as 13. The high G-value is interpreted as due to the fact that the cation radical is produced through the excited state of the charge transfer complex of pyridine with iodine. (auth)

19701 ESR STUDY ON IRRADIATED MONOMER AND POLYMER OF 3,3-BIS(CHLOROMETHYL)OXETANE. Tsuji, Kozo; Iwamoto, Takeo; Yoshida, Hiroshi; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 133-40(1965-1966). (In Japanese).

ESR spectra were studied for irradiated 3,3-bis(chloromethyl) oxetane (BCMO) single crystals and poly-BCMO obtained by polymerizing BCMO single crystals in solid state. In both cases, the spectra consist of the superposition of 2-line and 3-line components at −196°C. By warming the sample, only the former survived. From the examination of hyperfine coupling tensors, the free radicals were identified. The orientation of the free radicals gives information about the mode of ring opening in the solid state polymerization of BCMO. (auth)

19702 ESR STUDY ON RADIATION-INDUCED POLYMERIZATION OF ISOBUTENE. Tsuji, Kozo; Yoshida, Hiroshi; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 141-3(1965-1966). (In Japanese).

A mixture of 3-methylpentane and isobutene (2:1) was irradiated with ^{60}Co γ rays in darkness at 77°K. The ESR spectrum was a superposition of a 15-line spectrum with hyperfine separation of about 11 gauss and a sharp singlet spectrum. The latter is due to trapped electrons. The electrons were trapped much more stably in the mixture than in pure 3-methylpentane. The 15-line spectrum was assigned to a free radical $\cdot C(CH_3)_2CH_2R^+$ with two different configurations. Apparently, there is a charge transfer between 3-methylpentane parent cation and isobutene molecule which polymerized with a cationic mechanism. (auth)

19703 STUDIES ON RADIATION-INDUCED POLYMERIZATION BY ELECTRONIC SPECTROSCOPY. 1. ABSORPTION SPECTRA OF IRRADIATED NITROETHYLENE AT THE LOW TEMPERATURE GLASSY STATE. Kamiyama, Hideo (Japan Atomic Energy Research Inst., Takasaki); Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 145-57(1965-1966). (In Japanese).

Absorption spectra of irradiated nitroethylene were observed in the 77°K glassy state for various concentrations in 2-methyltetrahydrofuran with increasing irradiation time. A new absorption band was found at 440 mμ and assigned to the intramolecular charge transfer band of nitroethylene anion radical from its behavior for photobleaching and semi-empirical MO calculations, which also gave the value 1.53 eV as the electron affinity of nitroethylene. A competitive mechanism is suggested for the formation processes of trapped electrons and the anion radical. (auth)

19704 THE MECHANISM OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF TRIOXANE STUDIED BY POLARIZED LIGHT MICROSCOPY AND ELECTRON MICROSCOPY. Nishii, Masanobu; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 159-67(1965-1966). (In Japanese).

The variation of crystalline state of trioxane induced by radioinduced polymerization and the configuration of polymer produced were observed by polarized light microscopy and electron microscopy. By polarized light microscopic observation of polymer and monomer mixture, it was found that the polymer was produced homogeneously inside the monomer single crystal. No polymer nuclei and no polymer region were observed in the case of trioxane. Results of electron microscopic and x-ray diffraction analysis indicated that the polymer is a bundle of microfibrils with ~200 A width. Two mechanisms for the formation process of the polymer crystals were considered. (J.G.B)

19705 G VALUES OF METHYL RADICAL IN THE RADIOLYSIS OF PARAFFIN. Isoya, Toshiro; Hirota, Kozo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 181-2(1965-1966). (In Japanese).

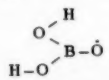
It has been previously reported that $G(CH_4)$ shows a linear relation against 1/n in two regions, where n is the structural unit in an irradiated molecule of $(CHR)_n$. This relation was applied to the G value of methyl radicals from paraffins. (auth)

19706 ESR STUDY OF IRRADIATED ORGANIC PHOSPHOROUS COMPOUNDS AT LOW TEMPERATURE. Sugimoto, Shunichi; Kuwata, Keiji; Ohnishi, Shunichi; Nitta, Isamu. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 199-215(1965-1966). (In Japanese).

The radicals formed in the γ irradiation of organic phosphorus compounds at low temperature were studied by ESR. In compounds in which the phosphorus atom takes p^3 hybridization such as monophenylphosphine, trimethyl phosphite, and related compounds, the main spectrum with regard to the phosphorus radical was an anisotropic doublet of 250 ~ 300 gauss separation and the g value close to the free spin value. This spectrum was assigned to the >$\dot{P}$ radical. While, in the sp^3 hybridized compounds such as trimethyl phosphate, dimethyl phosphite, and related compounds, the doublet with axial symmetry was observed. These spectra had 600 to 800 gauss separation and higher g value (2.02 ~ 2.03). These were assigned to the >P$\dot{O}$ (=O) radical. In addition to these radicals, some organic radicals such as cyclohexadienyl and phenyl radicals in monophenylphosphine, methyl radical in trimethyl phosphate and methoxy radical in trimethyl phosphite were also formed. (auth)

19707 THE ELECTRON SPIN RESONANCE STUDY OF AN IRRADIATED SINGLE-CRYSTAL OF BORIC ACID. Nagai, Siro; Kuwata, Keiji; Ohnishi, Shunichi; Nitta, Isamu. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 217-24(1965-1966).

The nature and structure of free radicals produced after irradiation of single crystals of deuterated and normal orthoboric acid were studied by electron spin resonance. The most likely structure of the free radical is



Results indicate that an unpaired electron of this radical occupies the $2p_y$ orbital of oxygen and interacts with ^{11}B and ^{1}H nuclei. The observed three values of g-tensor were assigned with respect to the molecular coordinate system. The isotropic hyperfine coupling constant of boron was interpreted with the calculated spin density on the 2s orbital of boron being in reasonable agreement with the experimental value. The anisotropic hyperfine coupling constants of boron and hyperfine coupling constant of hydrogen are explained qualitatively. (J.G.B.)

19708 RADIATION CHEMISTRY AND RADIATION DAMAGE. Aagaard, P.; Christensen, H.; Nilsson, G. (Aktiebolaget Atomenergi, Stockholm). Svensk Kem. Tidskr., 79: No. 2, 122-30 (1967). (In Swedish).

Wood–plastic combinations were made by radioinduced polymerization. The properties of the products were investigated. The radiolytic formation of phenol in the benzene–water system are considered. The decomposition of hexane adsorbed on silica gel was studied by means of gas chromatography and ESR spectroscopy. Pulse radiolysis technique was used for determination of the spectrum of the OH-radicals in water, and to find the spectrum of solvated electrons in ice. The radiation damage of uranium metal and uranium dioxide was studied. The number of uranium atoms sputtered per emitted fission fragment is reported. (INIS-Sweden)

19709 COLLOIDAL GOLD: STUDY OF THE PROGRESS OF COLLOID FORMATION BY SPECTROPHOTOMETRY, IODOMETRY, AND RADIOMETRY. Iya, V. K.; Gopal, N. G. S.; Chowdhary, S. Y. (Atomic Energy Establishment, Trombay, India). Indian J. Chem., 5: No. 2, 45-7(1967).

Colloidal radiogold was prepared by reacting sodium aurate (^{198}Au) with a gelatin solution containing a small quantity of a seed colloid prepared by treating nonradioactive chloroauric acid with an alkaline solution of glucose and gelatin. The progress and mechanism of formation of the two colloids, viz., seed colloid and the final colloid, were shown to be different by spectrophotometric studies. The formation of seed colloid is rapid, while the formation of the final colloid is dependent on time and temperature, and is complete only after autoclaving at 15 psi for 30 min. These findings were substantiated by iodometry and radiometry. (auth)

19710 PREPARATION OF A DRY ^{228}Th SOURCE OF THORON. Hursh, J. B.; Lovaas, A. I. (Univ. of Rochester, N. Y.). J. Inorg. Nucl. Chem., 29: 599-600(Mar. 1967).

A modification in the process of preparing a dry Ba(Th) stearate source of radon is described. Methyl alcohol is used instead of of water as the solvent for the reactants, allowing the reaction to be carried out at room temperature and yielding 99.8% recovery of ^{228}Th. (auth)

19711 A NEW METHOD FOR OBTAINING THE RADIOISOTOPES ^{54}Mn AND $^{55+59}Fe$ OF HIGH RADIOCHEMICAL PURITY. Bebesel, Pavel I.; Turcanu, Corneliu N. (Institut de Physique Atomique de l'Academie, Bucharest). Rev. Roum. Chim., 11: 1345-9(Nov. 1966). (In French).

A method is presented for obtaining ^{54}Mn beginning with natural iron irradiated in the nuclear reactor VVR-S. The method makes evident the possibility of simultaneously obtaining ^{54}Mn and ^{55}Fe + ^{59}Fe of high radiochemical purity. The separation of ^{54}Mn is accomplished by its transformation into a colloidal solution of hydrated manganese dioxide and by its concentration on an aluminum column. The method is very simple and makes it possible to obtain ^{54}Mn and ^{55}Fe + ^{59}Fe with a maximum yield and in chemical forms easy to use. (tr-auth)

19712 CATALOGUE OF RADIOACTIVE PRODUCTS, 1967/68. Amersham, Eng., Radiochemical Centre, United Kingdom Atomic Energy Authority. 215p.

The availability of radioactive products is listed under the following section headings: radioisotopes and labeled compounds; medical products; radiation sources (industrial and laboratory); radioactive material for instrument calibration; and services available. General information on ordering, distribution, packaging, delivery, insurance, prices and payment, and licensing and registration is also included. (UK)

19713 PROCESS OF PREPARING CHLORINATED HYDROCARBONS. (to Japan Atomic Energy Research Inst.). British Patent 1,055,410. Jan. 18, 1967. Priority date Sept. 22, 1964, Japan.

A process is described for the radioinduced reaction of Cl_2 gas with a saturated or partly chlorinated saturated hydrocarbon having not more than 7 C atoms. The process is also applicable to the chlorination of solid or molten paraffin. The ionizing radiation may be either gamma radiation from a ^{60}Co source or an electron beam. (B.L.M.)

19714 PROCESS FOR THE PRODUCTION OF THE PHOSPHORUS ISOTOPE ^{33}P. Godar, Serge (to EURATOM). British Patent 1,057,154. Feb. 1, 1967. Priority date June 19, 1963, Belgium.

A process is described for the production of ^{33}P that is essentially free of ^{32}P by the reaction $^{33}S(n,p)^{33}P$ using natural S as the starting material. The characteristic feature of the method is the use of neutrons obtained by the use of accelerated protons having an energy of about 2.7 MeV to produce the reaction $^{7}Li(p,n)^{7}Be$. (B.L.M.)

Radiochemistry

Refer also to abstract 19951.

19715 ^{13}C–^{31}P SPIN–SPIN COUPLING IN ORGANOPHOSPHORUS COMPOUNDS. McFarlane, W. (National Physical Lab., Teddington, Eng.). Chem. Commun., No. 2, 58(1967).

The signs and magnitudes of $^{13}C-^{31}P$ coupling constants were determined in dimethylphenylphosphine and its protonated cation $(CH_3)_2C_6H_5P^+H^1$, since the ^{31}P spectra are relatively uncomplicated by coupling with the protons of the phenyl group, and are more easily manipulated than trimethylphosphine. Experimental details are outlined and results tabulated. Quaternization of the phosphorus atom resulted in a change in sign of $J(^{31}P\ldots{}^{1}H)$, in accordance with the results of other workers' studies of Group III complexes of trimethylphosphine, and it was evident that the absolute value of the coupling constant decreases on complex formation. A large difference in the values of $J(^{13}C-^{31}P)$ in the phosphine and its hydrobromide suggests that this parameter is sensitive to the groups attached to the P atom, and it may assume considerable importance in studies of organophosphorus compounds. (UKAE)

19716 RADIOCHEMICAL METHODS IN THE STUDY OF PLATINUM METAL CATALYSIS. A REVIEW OF RECENT APPLICATIONS. Thomson, S. J.; Webb, G. (Glasgow Univ.). Platinum Metals Rev., 11: No. 2, 46-8(Apr. 1967).

Because of their extreme sensitivity, radiochemical methods are of great help in the study of catalytic processes. Changes at a surface at concentrations less than those required to yield monolayer coverage can readily be detected without interrupting the system for analysis. The application of such methods to the determination of metal areas and of catalytically active areas in supported metal catalysts is described, and also the usefulness of the methods in the study of electrocatalysis and in the unravelling of catalytic reaction mechanisms. (auth)

19717 CHEMICAL REACTIONS IN CONJUNCTIONS WITH NUCLEAR PROCESSES. Stoecklin, Gerhard (Kernforschung-

sanlage, Juelich, Ger. Univ., Cologne). Nukleonik, 8: 410-23 (Sept. 1966). (In German).

A bibliographic review is given of basic studies on chemical reactions in conjunction with nuclear processes. The origin of hot atoms, energy loss of recoil atoms, experimental possibilities, reaction models, and reactions of hot atoms in organic systems are considered. (129 references.) (J.S.R.)

19718 THE CHEMICAL STATE OF ^{32}P ATOMS RESULTING FROM THE NUCLEAR REACTION $^{32}S(n,p)^{32}P$ IN ELEMENTAL SULFUR. II. THE EXTRACTION OF RADIOPHOSPHORUS IN THE FORM OF $^{32}POCl_3$. Bebesel, P. I.; Turcanu, C. N. (Institut de Physique Atomique, Bucharest). Rev. Roum. Chim., 12: 95-101(Jan. 1967). (In French).

The chemical state of atoms of radiophosphorus resulting from the nuclear reaction $^{32}S(n,p)^{32}P$ was studied by the reaction that takes place between the ^{32}P atoms and phosphorus pentachloride. The existence of phosphorus oxychloride labeled with ^{32}P was identified by paper radiochromatography. The formation of the oxychloride implies the existence of ^{32}P atoms in the irradiated sulfur, in the form of the oxide, that can react with the phosphorus pentachloride. (tr-auth)

19719 CHEMICAL RESEARCH AT THE SWEDISH ATOMIC ENERGY COMPANY. Svenke, E. (Aktiebolaget Atomenergi, Stockholm). Svensk Kem. Tidskr., 79: No. 2, 89-93(1967). (In Swedish).

A survey is given of facilities and research in nuclear sciences in the company. Development of equipment, facilities, methods, and procedures for research in radioactive environments, processing techniques and radiation sources, rare construction materials for nuclear applications, and transportation equipment for radioactive materials was continued. Research on activation analysis, corrosion, fuel reprocessing, heavy water production, isotope production and technology, prospecting of uranium deposits, radiation chemistry, transuranium chemistry, uranium production and enrichment, and waste handling was the basic activity. (INIS-Sweden)

19720 TRITIUM AND ITS COMPOUNDS. Evans, E. Anthony. Princeton, N. J.; D. Van Nostrand Co., Inc., 1966. 450p. $15.00.

A study of published work on the properties and uses of tritium as a tracer is supplemented with critical discussions in an attempt to illustrate the fundamental principles of working with tritium. Topics handled include: physical properties and natural and artificial production of the isotope; precautions in handling; preparation and uses of labeled compounds with a discussion on measurement of tritium activity by beta liquid scintillation counting and other methods; and those properties which are peculiar to tritium compounds. A short note on nomenclature of tritium is included. Emphasis is placed on tritiated organic compounds. (P.C.S.)

Separation Processes

Refer also to abstracts 19719 and 19892.

19721 (IA-1058) PURIFICATION OF A ^{121m}Sn SOURCE. Locker, B. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Oct. 1965. 12p. Dep.mn.

A new method for purifying irradiated Sn is described. The main impurities are Zn, Cs, Sb, In, and Te. SnO_2 is fused with NaOH, dissolved, passed through an anion exchange column, and then precipitated either by thioacetamide or by phenylarsonic acid. Gamma and beta spectra show a decontamination factor of 15 to 20. (auth)

19722 (IN-1069) LABORATORY FEASIBILITY STUDIES OF AQUEOUS REPROCESSING OF ZIRCONIUM DIOXIDE–URANIUM DIOXIDE FUELS. Butzman, R. G.; Newby, B. J. (Idaho Nuclear Corp., Idaho Falls). Mar. 1967. Contract AT(10-1)-1230. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A three-step batch dissolution process for Zircaloy-4-clad zirconium dioxide–uranium dioxide fuels (such as PWR Core 2 Seed 1) using aqueous hydrofluoric acid and chromic acid solutions is proposed, and a chemical flowsheet is given with supporting data. A limited investigation on UO_2–ZrO_2–CaO wafers, using the same flowsheet, showed that wafers containing CaO dissolve about one-tenth as rapidly as those composed of UO_2 and ZrO_2 only. (P.C.H.)

19723 (IS-T-138) THE CHEMISTRY OF LANTHANIDE EXTRACTION FROM AQUEOUS CHLORIDE, NITRATE, AND PERCHLORATE SOLUTIONS FOR THE EXTRACTANT DI-(2-ETHYLHEXYL) PHOSPHORIC ACID. Lenz, Terry Gene (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 64p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Equilibrium data have been obtained for the system $SmCl_3$–HCl–H_2O–1M bis(2-ethylhexyl)phosphoric acid (D2EHPA)–Amsco (a hydrocarbon diluent). These data are plotted using equilibrium aqueous acid concentration as a parameter. The shape of the equilibrium curve may be explained in terms of increasing HCl activity as aqueous ionic strength increases, decreasing free extractant concentration as organic metal concentration increases, and possible complexing between samarium and chloride in the aqueous phase. Solvent-dependency and acid-dependency studies have also been carried out for the chloride system. These studies indicate that samarium is extracted from chloride media into D2EHPA–Amsco solutions according to the conventional ion-exchange reaction at low, moderate, and high aqueous samarium chloride concentrations. Equilibrium data are also presented for the $Sm(ClO_4)_3$–$HClO_4$–H_2O–1M D2EHPA–Amsco and $Nd(ClO_4)_3$–$HClO_4$–H_2O–1M D2EHPA–Amsco and for the $SM(NO_3)_3$–HNO_3–H_2O–1M D2EHPA–Amsco systems. Separation factors, $\beta_{Sm,Nd}$, are presented as a function of equilibrium aqueous lanthanide concentration for the system $Nd(ClO_4)_3$–$Sm(ClO_4)_3$–$HClO_4$–H_2O–1M D2EHPA–Amsco. Correlation of these separation factor data with a rigorous expression for the separation factor indicates that the marked decrease of $\beta_{Sm,Nd}$ at high aqueous lanthanide perchlorate concentrations is due to the appearance of the neutral species extraction reaction. Thus, the conventional ion-exchange reaction is more selective between samarium and neodymium than is the neutral species reaction. This observation suggests that the chloride system would be best for large-scale lanthanide separation with D2EHPA, since separation factors are greatest for extraction from chloride media at high aqueous lanthanide concentrations. (P.C.H.)

19724 (MCW-1509) PLANT-SCALE FLUID-BED DENITRATOR. Robinson, S. N.; Todd, J. E. (Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.). Aug. 1, 1966. Contract W-14-108-eng-8. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A plant-scale fluid-bed denitration system was installed in the Weldon Spring Refinery in May, 1964. Operation of the unit since that time has not been successful in producing UO_3 reactive enough to be hydrofluorinated to satisfactory UF_4 using low HF excess (1.10 × theory or less). However, when the as-produced UO_3 is soaked in uranyl nitrate, the resulting product is as reactive as pot UO_3, and it can be processed to UF_4 using low HF excesses. (auth)

19725 (ORNL-4088) GEOMETRIC SCALING OF STACKED-CLONE CONTACTORS. Finsterwalder, L. O. (Oak Ridge National Lab., Tenn.). Apr. 1967. Contract W-7405-eng-26. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study of the effect of geometric scale-up on the performance of the stacked-clone contactor, which is a high-performance, liquid-liquid, countercurrent solvent extraction device, has been completed. Units 0.5 and 1.4 times the size of the original contactor have been tested. Hydraulic data for these machines showed solution throughput to be 40 and 119% of the original MK X machine, respectively. Mass-transfer stage efficiencies were obtained, using uranyl nitrate in the system 1M $NaNO_3$–18% TBP in Amsco. The results averaged 85% for the smaller, and 74% for the larger, contactor. The validity of the obtained scale-up factors for other chemical systems was demonstrated with the half-scale unit using the system HNO_3–0.8M $Al(NO_3)_3$–40% TBP in Amsco. (auth)

19726 (ORNL-TM-1701) CONVERSION OF URANIUM CHLORIDES TO URANIA BY GAS-PHASE REDUCTION HYDROLYSIS. Patterson, F. H.; Robinson, W. C. Jr.; Leitten, C. F. Jr. (Oak Ridge National Lab., Tenn.). Apr. 1967. Contract W-7405-eng-26. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Uranium chlorides are obtained from the chlorine volatilization process presently being considered for Zircaloy-clad fuels. A program was undertaken to investigate the feasibility of converting these gaseous chlorides to uranium oxide powder by reaction with hydrogen and water vapor. The parameters investigated in these feasibility studies included a temperature range of 660 to 960°C and pressures of 1 to 6 torrs. The uranium chloride was successfully converted to microfine urania powder in this experimental range. This definitely establishes the feasibility of conversion of the product of the chloride volatilization process back to usable fuel material. (auth)

19727 (RLO-1053-3) SEPARATION EFFICIENCY OF SOLVENT EXTRACTION SYSTEMS. Progress Report No. 10, October 1, 1965–September 30, 1966. Babb, Albert L. (Washington Univ., Seattle. Dept. of Nuclear Engineering). Oct. 1, 1966. Contract AT(45-1)-1053. 203p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The model for transient holdup has been revised. The derivation for the revised stagewise model is presented and the similarity to the differentially continuous model pointed out. Using purely theoretical considerations another holdup model has been developed using distribution functions to provide for drop size and turbulence effects. The ability to measure holdup by dye fluorescence has been verified and a series of runs completed. Using these data the characteristics of the dye fluorescence measurement technique have been studied. Experiments have been performed to determine the effect of interfacial tension upon holdup. By equilibrating acetic acid between methyl isobutyl ketone and water, the interfacial tension can be regulated and instabilities resulting from interfacial tension gradients avoided. An article on dispersed phase mixing in pulsed sieve plate solvent extraction columns is appended. (P.C.H.)

19728 INFLUENCE OF DIFFERENT MOMENTS OF INERTIA ON THE THERMAL DIFFUSION OF $H^{35}Cl$, $D^{35}Cl$, $H^{37}Cl$, AND $D^{37}Cl$. Meier, Werner (Univ., Zurich). Helv. Chim. Acta, 50: 405-11 (1967). (In German).

Analysis of measurements of the thermal diffusion factor α in the systems $H^{35}Cl/H^{37}Cl$, $D^{35}Cl/D^{37}Cl$ and $H^{35}Cl/D^{35}Cl$ shows that α may be approximated by the expression $\alpha = C_m (m_1 - m_2/m_1 + m_2) + C_\theta (\theta_1 - \theta_2/\theta_1 + \theta_2)$, where C_m still depends on the moment of inertia. The values of C_m and C_θ are: $H^{35}Cl/H^{37}Cl: C_m = 0.0818$; $D^{35}Cl/D^{37}Cl: C_m = 0.100$; $H^{35}Cl/D^{35}Cl: C_m = 0.0909$; $C_\theta = -0.00645$. Kihara's theory yields a value for C_m too small by a factor 1.42. C_θ calculated from Trübenbacher's theory differs from the experimental value by 23% only. (auth)

19729 SEPARATION OF TANTALUM AND NIOBIUM BY SOLVENT EXTRACTION. Butters, P. A. Chem. Ind. (London), 15: 613-15(Apr. 15, 1967).

From Inaugural Meeting of Solvent Extraction Group of Society of Chemical Industry, London, Oct. 28, 1966.

A description is given of a continuous plant process employing methylisobutyl ketone from HF or HF/H_2SO_4 aqueous medium. Subsequent addition of KF solution to the ketone extract precipitates the tantalum quantitatively as K_2TaF_7, and similar addition to the aqueous solution precipitates the niobium as K_3NbOF_6. The process employs a multistage box-type mixer–settler system. A simplified flow sheet is shown. Each product contains <100 ppM of the other element. Metal powder is produced by reduction with metallic sodium. (UK)

19730 QUANTITATIVE THIN-LAYER CHROMATOGRAPHY. III. DETERMINATION OF URANIUM WITH MDCM AFTER SEPARATION OF METALS OF THE AMMONIUM SULFIDE GROUP. Gagliardi, E.; Pokorny, G. (Univ., Graz). Mikrochim. Acta, No. 2, 228-32(1967). (In German).

The thin layer chromatographic separation of uranium from metals of the ammonium sulfide group is described. The mobile phase is an acetone–isobutanol–hydrochloric acid–water mixture. After dissolving off the sorption layer, the uranium was washed out and determined spectrophotometrically with 4-morpholinecarbodithoic acid morpholine (MDCM). The pH and time relationship of the uranium–MDCM complex were studied and the precision of the method is given. (auth)

19731 PROPERTY CHANGES OF ION EXCHANGE RESINS AFTER THEIR APPLICATION FOR RADIOACTIVE WASTE MANAGEMENT. Rauzen, F. V.; Solov'eva, Z. Ya. At. Energ. (USSR), 21: 378-81(Nov. 1966). (In Russian).

Changes in properties of ion-exchange resins, used a long time for purification of low-activity waste water, in commercial installations for laboratory sewage are reported. The resins were darkened and reduced to fragments, and dynamic exchange capacities were reduced 30 to 45%. The coefficients for purification of solutions from ^{137}Cs, ^{90}Sr, and ^{35}S were not reduced in comparison with the purification coefficients obtained during use of the original ion-exchange resin. Processing with 0.5N solutions of nitric acid increased the capacity of the anion-exchange resin AN-2F by 20%. After three years of operation, the ion-exchange resins are considered adequate for long-term use in purification stations. (tr-auth)

19732 TUNGSTEN CRUCIBLES IN PYROCHEMICAL PROCESSING OF NUCLEAR FUELS. Winsch, I. O.; Kyle, M. L.; Pierce, R. D.; Burris, L. Jr. (Argonne National Lab., Ill.). Nucl. Appl., 3: 245-51(Apr. 1967).

Two-phase systems of zinc or zinc-rich alloys and molten chloride salts are being employed at temperatures up to 800°C in developing pyrochemical processes for the recovery of uranium and plutonium from partially spent reactor fuels. Tungsten was chosen as the crucible material because it and certain of its alloys possess excellent chemical resistance to these highly corrosive molten systems. Several methods of fabrication were employed to produce the crucibles that were tested under process conditions. These methods include: pressing and sintering; shear forming; arc welding of rolled sheet; plasma spraying of free-standing tungsten shapes; and plasma spraying of tungsten on substrate materials. Both pressed-and-sintered and shear-formed tungsten crucibles have given excellent service and reliability. Crucibles formed by plasma spraying tungsten on a mandrel show promise. Tungsten crucibles formed by arc welding or plasma spraying of tungsten on a substrate were unsatisfactory. (auth)

19733 THE LOW-TEMPERATURE CHROMATOGRAPHIC SEPARATION OF THE ISOTOPIC HYDROGENS AT 27 AND 55°K. Haubach, W. J.; Knobler, C. M.; Katorski, A.; White, David (Ohio State Univ., Columbus). J. Phys. Chem., 71: 1398-1402(Apr. 1967).

The chromatographic separation of the molecular species, H_2, D_2, and HT, as well as the nuclear spin species, ortho-parahydrogen and deuterium, were investigated at 27 and 55°K. At these low temperatures, it was found that the retention times on γ-alumina are strongly dependent on the volume of the sample introduced into the column. In the limit of low surface coverage, it was found that the separation factors deduced from the retention times are in fair agreement with the theory of Katorski, White, and Lassettre. Furthermore, as predicted by the theory, the retention time for the heteronuclear HT is smaller than that of the homonuclear D_2 of the same mass. (auth)

19734 QUANTITATIVE SEPARATION OF THORIUM AND ZIRCONIUM ON THE KU-2 CATION EXCHANGE RESIN IN A HYDROCHLORIC ACID MEDIUM. Alimarin, I. P.; Medvedeva, A. M. (Moscow Inst. of Fine Chemical Tech.). Zh. Anal. Khim., 22: 436-8(Mar. 1967). (In Russian).

Separation of thorium and zirconium on the KU-2 cation-exchange resin was studied. Due to the selective interaction of thorium ions with the KU-2 cation-exchange resin thorium was quantitatively sorbed from 3 to 4N HCl solutions. Zirconium under these conditions passed into the filtrate. Thorium and zirconium were separated at different ratios. Zirconium was determined by the photometric method with the use of Arsenazo III. Thorium was determined photometrically by means of Arsenazo III after it was desorbed with ammonium oxalate. The method also permits separation of thorium from cerium and other rare earth elements as they are not sorbed by the cation exchange resin from 3 to 4N HCl. (auth)

19735 USE OF CINNAMIC ACID IN ANALYTICAL CHEMISTRY. COMMUNICATION 10. DETERMINATION OF SCANDIUM AS CINNAMATE AND ITS SEPARATION FROM THE RARE EARTH ELEMENTS AND YTTRIUM. Volkov, I. I.; Ostroumov, E. A. (Inst. of Oceanology, Moscow). Zh. Anal. Khim., 22: 340-5(Mar. 1967). (In Russian).

Scandium was quantitatively precipitated with cinnamic acid from a nitric acid solution at pH 1.8 and above. When the pH of the solution at the end was not more than 3, scandium precipitated as trisubstituted cinnamate of a constant composition $SC(C_6H_5CH:CHCOO)_3$, which is a new weight form for scandium determination. The determination of scandium under these conditions permitted its separation from the rare earths and yttrium. Rare earths and yttrium were quantitatively precipitated from the filtrates after scandium separation as trisubstituted cinnamates of a constant composition by increasing the pH of the solution with ammonia. (auth)

19736 THE DISTRIBUTION OF ^{210}Po AND ^{210}Bi BETWEEN LINEAR ALIPHATIC ETHERS AND NITRIC ACID SOLUTIONS. Sheppard, J. C. (Battelle Memorial Inst., Richland, Wash.). J. Inorg. Nucl. Chem., 29: 848-53(Mar. 1967).

The effect of the oxygen-to-carbon ratio of linear aliphatic ethers on the extraction of Po(IV) and Bi(III) from HNO_3 was studied. Experiments were performed at room temperature by the equilibration of equal volumes of the organic and aqueous phases. Only dibutylcarbitol and 1,4-diethoxybutane showed promise with respect to the separation of Po(IV) from Bi(III). (P.C.H.)

19737 THE POSSIBILITY OF USING THE MOLECULAR SIEVE 4A IN DECONTAMINATION OF FISSION PRODUCT AQUEOUS SOLUTIONS. Susic, Milenko V.; Radak, Vukosava M. (Univ., Belgrade). Bull. Boris Kidrich Inst. Nucl. Sci., 17: 243-5(July 1966).

The adsorption efficiency of a column with the molecular sieve 4A for separation of fission products from solutions of high specific activity and very low molar concentration was investigated. A solution containing ^{137}Cs, ^{152}Eu, ^{144}Ce, ^{106}Ru, and ^{60}Co was passed through the column and 94.4% of the initial activity was adsorbed. The activity of the solution after passing through the column was almost completely due to ruthenium, while the other elements were completely adsorbed. (M.C.G.)

19738 ADVANCES IN THE FIELD OF SEPARATING STABLE ISOTOPES BY CHEMICAL EXCHANGE. Ciric, M.; Krell,

E.; Kulicke, P.; Missbach, D.; Muehle, K.; Schuetze, H.; Stiehl, G.; Thiel, S.; Weise, G.; Wetzel, K. (Boris Kidric Inst. for Nuclear Research, Belgrade). Isotopenpraxis, 3: 21-6(Jan. 1967). (In German).

Processes and methods utilized for the separation of various stable isotopes by chemical exchange are surveyed. A method for determining the rate of fast isotope-exchange reactions is described. (auth)

19739 INVESTIGATION OF THE SEPARATION OF NITROGEN AND OXYGEN ISOTOPES BY NITROGEN OXIDE DISTILLATION. Asatiani, P. Ya.; Garshin, N. A.; Gverdtsiteli, I. G.; Kucherov, R. Ya.; Kushchenko, N. I.; Levchenko, M. N.; Minenko, V. P.; Nikolaev, Yu. V.; Oziashvili, E. D.; Petriashvili, I. M. Isotopenpraxis, 3: 29-32(Jan. 1967). (In Russian).

The system of transport equations for separation of multicomponent isotope mixtures in stepped cascades was analytically derived and solved. On this basis the concentration distribution of oxygen and nitrogen isotopes along the cascade in steady state was calculated for various discharges. Graphs of the results are given. The method described is suitable for large-scale production of highly enriched nitrogen and oxygen isotopes. (auth)

19740 CATHODE POLONIUM DEPOSITION ON PLATINUM ELECTRODE FROM NITRIC ACID SOLUTIONS. Mihailova, V.; Boyadjiev, L. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 199-205(1966). (In Russian).

Conditions for an effective electrolytic separation of polonium from nitric acid solutions with a concentration of 3×10^{-16} to 6×10^{-15} mol/l were studied. The influence of the concentration, acidity, and temperature of the solution on the cathode yield of polonium was examined. Keeping a constant voltage of 3.7 V and a current density of 186 to 190 mA/cm^2 polonium deposited on the platinum electrode with a yield of more than 80% in the whole range of the concentrations employed. The optimum acidity of the medium was from 1 to 2N. In the temperature range under investigation (50 to 90°C) maximum cathode yield of polonium occurred at 80°C. Electrolysis under these conditions took one hour. No deposition of polonium on the anode was observed. (auth)

19741 INFLUENCE OF A SODIUM HOLDBACK CARRIER ON THE RADIOCHEMICAL SEPARATION OF POTASSIUM AS ITS PERCHLORATE. Rakovic, Miloslav; Prochazkova, Zdenka (Charles Univ., Prague). Chem. Anal. (Warsaw), 12: 9-12(1967).

The dependence of the radiochemical purity of potassium perchlorate precipitate on the amount of the carrier element that should remain in solution (sodium) was studied. The results have a general meaning for neutron activation analysis and indicate that more attention should be given to the amount of the carrier used. Higher concentrations of the carrier can increase coprecipitation instead of causing its reduction. (auth)

19742 SEPARATION OF URANIUM AND RARE EARTH ELEMENTS ON SULFONIC CATION EXCHANGER KU-2. I. EXPERIMENTS ON APPLICATION OF PRECIPITATING REAGENTS. Krawczyk-Obojska, Irena (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw), 12: 13-21(1967). (In Polish).

Possibilities of separation of uranium(VI) and rare earth elements(III) on sulfonic cation exchanger KU-2, using 1N solutions of $K_4Fe(CN)_6$, NH_4OH, $H_2C_2O_4$, NaF, KF, and NH_4F, were investigated. It was found that only $H_2C_2O_4$, NaF, KF, and NH_4F solutions can find application in this case. (auth)

19743 SOME PROBLEMS IN THE SEPARATION OF TRACES OF ELEMENTS BY PRECIPITATION. II. MECHANISM OF THE SORPTION OF URANIUM(VI) FROM A CARBONATE MEDIUM. DESORBENT ACTION OF THORIUM HYDROXIDE. Upor, Endre. Acta Chim. Acad. Sci. Hung., 51: 119-37(1967).

A solution containing $[UO_2(CO_3)_3]^{4-}$ ions was treated with various adsorbents. It was found that uranium losses are due, quite independently of the chemical nature of adsorbents, almost entirely to the decomposition of the complex, and to the binding of UO_2^{2+}-ions. The uranium-binding capacity of some metal oxides, hydroxides, and phosphates was investigated, and it was found to range >1 milliequivalent per g under the applied experimental conditions with hydroxides and phosphates employed as inorganic ion exchangers. The desorbent effect of thorium hydroxide was examined in detail. It was proved that this effect prevails throughout in the pH range 7.7 to 13.0, and that in the presence of thorium the second peak caused by hydroxyl ions does not appear. The desorbent effect is interpreted by the high carbonate-binding capacity of thorium hydroxide, and, respectively, by its low basicity, which limit the binding of hydroxyl ions. The dependence on pH values of the adsorption of carbonate and hydroxyl ions was established with iron(III) hydroxide and thorium hydroxide. Results explain the correlation between uranium adsorption and pH values. The increase of uranium adsorption connected with the aging of the precipitate can be explained by the lack of binding of carbonate ions. On examining whether other cations (such as Zr^{4+}, La^{3+}, Ce^{3+}, Ce^{4+}, Y^{3+}, Zn^{2+}, Be^{2+}) have desorbent effects, the effect of thorium with iron(III) hydroxide proved to be specific. In rock analysis, adsorption losses are somewhat reduced by the presence of zirconium and lanthanum. This is ascribed to the fact that in the presence of these latter ions, though the carbonate adsorption does not increase, the binding of hydroxyl ions is of a small extent. (auth)

19744 SOME PROBLEMS IN THE SEPARATION OF TRACES OF ELEMENTS BY PRECIPITATION. III. SEPARATION OF SMALL QUANTITIES OF URANIUM(VI) FROM METAL HYDROXIDES BY MEANS OF ALKALI HYDROXIDES. INVESTIGATION OF THE COMPOSITION OF THE URANATE PRECIPITATE. Upor, Endre. Acta Chim. Acad. Sci. Hung., 51: 139-49(1967).

The behaviour of uranium(VI) in alkali hydroxide medium was studied in detail. It was found that small quantities of uranium, quantitatively precipitated on iron(III) hydroxide up to the pH value of 12, dissolve gradually when the pH is further increased. The dissolution is quantitative at pH 13 to 14 if the concentration of uranium is 5×10^{-4} M. On increasing the concentration of the electrolyte or with increasing time, the solubility decreases. The composition of the precipitate formed on the addition of NaOH was studied at higher uranium concentrations (0.005 to 0.02 M/lit.) and it was found that the Na : U ratio of the precipitate is 1.00 ± 0.04 within the pH range between 11.8 and 13.0. This ratio corresponds to the composition $Na_2U_2O_7$, disproving the existence of Na_2UO_4 proposed by several authors for this pH range. In NaCl solutions of higher concentration or after a longer period of standing, the Na : U ratio increases to 1.25. This is possibly due to coprecipitation of NaOH. The high NaOH-(OH^-) adsorption is also substantiated by the fact that the dissolution of uranium is a colloidal process. The latter statement was also proved by electron microscopy. Studies were also carried out concerning precipitation of uranium with $Ba(OH)_2$ and $Ca(OH)_2$. The dissolution of uranium(VI) in alkaline medium can be utilized both in preparative and in analytical chemistry. So far the method has been applied primarily for the separation from thorium in the determination of the thorium content of uranium ores, as well as for the preparation of UX_1, and for the radiochemical purification of uranium. (auth)

19745 OBSERVATIONS ON THE SEPARATION FACTORS OF THE RARE EARTHS WITH VARIOUS LIGANDS. Rowlands, D. L. G. (Ames Lab., Iowa). Contract W-7405-eng-82. J. Inorg. Nucl. Chem., 29: 809-14(Mar. 1967). (IS-1423).

It was reported that the separation factors of the rare earths in the system HEHϕP–HCl aq. (HEHϕP = 2-ethylhexylphenylphosphonate) showed some regularities when plotted as a function of the atomic number of the element. The properties apparent in the first subgroup La to Gd were repeated in the second subgroup Gd to Lu. It was further suggested that a parallel was observed for the ligands HDEHP (di-2-ethylhexylphosphonate) and EDTA and that correlations existed for the systems NTA (nitrilotriacetic acid), TBP, 2-hydroxyisobutyric acid, and other hydroxy acids. While these conclusions may be valid for the phosphonic acid derivatives, it seems doubtful that the other ligands exhibit any regularities. Data representing fifteen complexing agents are presented in an attempt to clarify the position. (auth)

19746 PARTITION CHROMATOGRAPHY OF URANIUM AND FISSION PRODUCTS ON A POROUS STYRENE–DIVINYL BENZENE COPOLYMER SWOLLEN IN TRIBUTYLPHOSPHATE SOLUTION. II. CONTRIBUTION TO THE STUDY OF THE EXTRACTION MECHANISM OF NITRIC ACID AND URANYL NITRATE. Beranova, H.; Tejnecky, M. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 32: 437-43(Jan. 1967).

An attempt was made to verify the assumption that the mechanism for partition chromatographic extraction of nitric acid and uranyl nitrate with tributyl phosphate is the same as that for the liquid–liquid system extraction. Nitric acid was extracted with a 20 vol % solution of TBP in dichloroethane and with a solution of TBP absorbed in a copolymer. In the extraction of uranyl nitrate, the organic phase consisted of the copolymer with 10 or 4% divinylbenzene with a variable content of TBP and of dichloroethane, or of 5 to 50 vol % solution of TBP in dichloroethane. Results indicated that the usual equations for liquid-liquid extraction mechanism may be applied to partition chromatography. (J.G.B.)

19747 EXTRACTION OF Pu(IV) WITH DI-n-BUTYLPHOSPHORIC ACID FROM NITRATE AND PERCHLORATE SOLUTIONS. Kuca, L. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 32: 298-310(Jan. 1967).

The extraction of Pu(IV) from nitrate solutions with di-n-butylphosphoric acid solution (HDBP) in CCl_4 was studied. The composition of the extracted complexes and their extraction constants are as follows: Aqueous phase 1M-HNO_3 : Pu(NO_3) (DBP)$_3$(HDBP), log K = 7.8 ± 0.2; $Pu(NO_3)(\overline{DBP})_3(HDBP)_2$, log K =

10.0 ± 0.2; from 6M-(HnNa)NO_3: $Pu(NO_3)_2(DBP)_2 \cdot (HDBP)_2$, log K = 7.7 ± 0.2; $Pu(NO_3)(DBP)_3(HDBP)$, log K = 8.2 ± 0.3. In the case of extraction from perchlorate solutions the complexes $(Pu(ClO_4)_{4-n}(DBP)_n(HDBP)_{4-n}$ and $Pu(ClO_4)_{4-n}(DBP)_n(HDBP)_{5-n}$ were formed, however, their extraction constants were not calculated. The general relations in the formation of the dialkylphosphoric acids complexes with tetravalent ions are discussed. (auth)

19748 USE OF ZONE MELTING FOR PURIFICATION OF IRRADIATED NUCLEAR FUELS. von Ammon, Reinhard (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Nukleonik, 9: 65-9(Feb. 1967). (In German).

Experiments were conducted for purification of the potential nuclear-fuel UCl_4 from fission products and other impurities. In all cases the impurity distributed strongly towards the molten zone, thus moving towards the end of the sample. After 20 passes at a velocity of 10 mm/hr separation factors were obtained between $c/c_0 = 10^{-4}$ and 5×10^{-2} in the following order: $RuCl_3 < BaCl_2 < CsCl < CeCl_3 < NaCl < ZrCl_4$. Tracer concentrations showed the same behavior as higher concentrations (0.1 to 1 wt %). Zone refining of the UCl_4–KCl eutectic (44 mole % UCl_4) yielded less favorable results. Separation factors under comparable conditions were smaller by 1 to 2, for $RuCl_3$ even 3 orders of magnitude. $ZrCl_4$ is the only compound distributing towards the solid phase, but only if present in macro-concentrations. (auth)

19749 REPROCESSING OF NUCLEAR FUEL. Larsson, A. (Aktiebolaget Atomenergi, Stockholm). Svensk Kem. Tidskr., 79: No. 2, 94-102(1967). (In Swedish).

A review is given on the research in processing irradiated fuel elements. An investigation of suitable processes was initiated at the Research Institute of Swedish National Defense in 1948. Efforts were first directed towards development of technical separation processes followed by construction and operation of two pilot plants. Costs and engineering studies on industrial plants and considered chemical processes are reported. (INIS-Sweden)

19750 RECOVERY OF PLUTONIUM AND ITS USE IN NUCLEAR REACTORS. Hultgren, A. (Aktiebolaget Atomenergi, Stockholm). Svensk Kem. Tidskr., 79: No. 2, 103-12(1967). (In Swedish).

A pilot plant for plutonium recovery by extraction using tributyl phosphate and trilaurylamine is described. Process flow sheets and overall results from product–yield for uranium–plutonium separation and purification from fission products are presented. An outline of the plutonium-fuel development on pellet pressing and sintering of UO_2–PuO_2 prepared by physical mixing of oxides from co-precipitated uranium–plutonium salts is given. Intermediate and final products are examined by thermal analysis, x-ray diffraction, and metallographic testing. Pellets are encapsulated in Zircaloy before irradiation testing. (INIS-Sweden)

19751 ISOTOPE SEPARATION. Holmberg, K. E. (Aktiebolaget Atomenergi, Stockholm). Svensk Kem. Tidskr., 79: No. 2, 131-5(1967). (In Swedish).

A survey of research and development on hydrogen and uranium isotope separation supported and achieved by the Swedish Atomic Energy Company is given. Exchange distillation was used for separation of boron isotopes. Different separation processes and isotopic systems were investigated. Research on separation effects for hydrogen isotopes, on formation of vapor or ice from salt solutions, and solubility of salts in heavy water are continued. (INIS-Sweden)

19752 PROCESS FOR CHEMICALLY SEPARATING SUBSTANCES IN SOLUTION. Laveissiere, Francoise; Bonnin, Andre; Poirier, Philippe (to Saint Gobain Techniques Nouvelles). British Patent 1,057,933. Feb. 8, 1967. Priority date Mar. 16, 1963, France.

A process is described for the extraction of a substance existing in the form of a salt dissolved in a solvent in mixture with other substances by the selective fixation of the substance to be extracted on a solid insoluble in the solvent. The process is particularly applicable to the separation of Cs present in radioactive wastes as a fission product in nitrate form from an aqueous solution possibly containing salts of other fission products. The solid fixative material is prepared in a dispersion in colloidal form, is flocculated, extracted, and redispersed in an organic solvent before it is brought into contact with the solution of the substance to be separated. For the fixation of Cs, a colloidal dispersion of mixed ferrocyanides containing cations from transition elements and monovalent cations is mixed with a surface active agent, such as a quaternary ammonium salt to produce flocculation of the colloid, and the colloid is redispersed in a water-immiscible chlorinated solvent, alcohol, ketone, or hydrocarbon. (B.L.M.)

19753 SEPARATION OF A MIXTURE OF MOLECULES HAVING DIFFERENT WEIGHTS. (to Centre National de la Recherche Scientifique). British Patent 1,053,334. Dec. 30, 1966. Priority date Mar. 14, 1963, France.

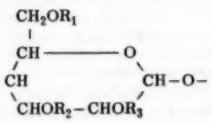
A separation process for molecules of different weights from a gaseous mixture in thermodynamic equilibrium is based on classification of the molecules according to the categories of their thermal agitation translation speeds. At least one molecular stream of the mixture is fed onto a moving surface so that diffusion of the mixture by contact with the surface is obtained. Fractions of the moving stream having thermal speeds within certain ranges are trapped at certain points along both sides of the moving stream adjacent to the moving surface. The trapped fractions are enriched in either the light or heavy molecules as compared with the original gaseous mixture. (B.L.M.)

19754 IMPROVEMENTS IN ION EXCHANGERS. (to Studiecentrum Voor Kernenergie). British Patent 1,057,925. Feb. 8, 1967. Priority date Aug. 20, 1962, Netherlands.

A method for the preparation of a cation exchanger that is usable in strong mineral acids comprises mixing a solution of Na_2MoO_4 and/or Na_2WO_4 with a solution of $H_4Fe(CN)_6$ in a strong acid solution, washing the precipitate at least once with 0.2 to 1M solution of the strong acid, and drying the precipitate. The solutions are mixed with a molar ratio of molybdate or tungstate to ferrocyanide of from 2/1 to 8/1. (B.L.M.)

19755 DESALINIZATION MEMBRANE. (to Regents of the University of California). British Patent 1,056,636. Jan. 25, 1967. Priority date Mar. 25, 1964, United States.

A method is described for the production of a semipermeable membrane for use in a simple process that can be made to approach thermodynamic reversibility to produce potable water from a sea water brine. For the membrane preparation, a solution is formed containing a cellulosic ester or ether having anhydroglucose units of the formula



where R_1, R_2, and R_3 are alkyl groups containing 1 to 8 C atoms or COR_5 where R_5 is an alkyl group containing 1 to 7 C atoms and a substantially water-soluble liquid amide having the formula $R_6CONR_7R_8$ in which R_6 is hydrogen, a methyl, or ethyl group and R_7 and R_8 are hydrogen or methyl, ethyl, or propyl groups. The solution is cast to form a membrane, and a portion of the liquid amide is evaporated for a predetermined period of time. The cast membrane is then immersed in water and finally heated to a temperature of 70 to 95°C to reduce its porosity. (B.L.M.)

19756 SEPARATION OF CERIUM FROM OTHER RARE EARTHS. (to United States Atomic Energy Commission). British Patent 1,056,196. Jan. 25, 1967. Priority date Apr. 20, 1964, United States.

Cerium is separated from mixtures with other lanthanide rare earths by extracting the cerium values and the other rare earths from the aqueous solution with a kerosene solution of bis(2-ethylhexyl)ester of phosphoric acid and TBP. The organic solution is then contacted with a fresh aqueous solution 0.5 to 10M in mineral acid and containing an alkali metal persulfate and silver nitrate. The Ce is oxidized to the tetravalent state and held in the organic phase while the other trivalent rare earths are back-extracted into the persulfate-silver aqueous solution. The phases are separated to allow the tetravalent Ce to return to the trivalent state, and it is then re-extracted into a dilute aqueous mineral acid solution. (B.L.M.)

19757 METHOD AND APPARATUS FOR THE PHYSICAL SEPARATION OF THE COMPONENTS OF A BINARY MIXTURE. Roche, Rene; Cousin, Phillipe (to Commissariat a l'Energie Atomique). British Patent 1,055,345. Jan. 18, 1967. Priority date June 18, 1964, France.

A process is described for the physical separation of two components of a binary mixture in which the components are capable of forming an azeotrope and in which at least one of the components can be readily condensed from the vapor state to the solid state. The major portion of one of the components of the mixture is crystallized directly from the vapor state under conditions of temperature and pressure such that the remaining vapor mixture contains only a low proportion of one component. The remaining vapor mixture is condensed and distilled in a fractionating column so that vapors of an azeotropic mixture of the two components are withdrawn from the head of the column while the second component collects as a liquid at the base of the column. This method results in the isolation of each component in a virtually pure state. The process is particularly suitable for the separation of mixtures of UF_6 and HF. (B.L.M.)

EARTH SCIENCES

Geology

Refer also to abstract 20690.

19758 (IDO-22048) HYDROLOGY OF THE NATIONAL REACTOR TESTING STATION AREA, IDAHO. Annual Progress Report, 1965. Barraclough, J. T.; Teasdale, W. E.; Jensen, R. G. (Geological Survey, Idaho Falls, Idaho). Feb. 1967. 118p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study was undertaken, by the U. S. Geological Survey, to determine the effects of radioactive waste disposal to the basalts of the Snake Plain aquifer. Ground- and surface-water samples were collected for chemical and radiometric analyses. The results were evaluated and mapped. Groundwater levels were also monitored and mapped. Pumpage and waste disposal data are given. A record flood of the Big Lost River enabled recharge effects, infiltration rates, vertical percolation rates, and pressure transmission to be determined. Studies of air flow in the zone of aeration were continued. Study of internal fluid flow in wells showed that no consistent flow direction exists. The natural gamma spectra of rocks were determined. Seismic effects on well hydrographs were evaluated. Effects of radioactive waste disposal to ponds and wells are described and mapped. Tritium is the only waste radionuclide at the National Reactor Testing Station that can readily be detected in groundwater at significant distances from points of disposal. Tritium concentrations in groundwater decreased principally because less waste was discharged. The tritium front in the aquifer lies about 4 miles south of the Idaho Chemical Processing Plant disposal well. Strontium-90 has also been detected in groundwater almost half a mile south of the disposal well. (auth)

19759 (NP-16464) BIOACCUMULATION OF RADIONUCLIDES ON GRANITIC OUTCROPS IN THE GEORGIA PIEDMONT. Final Report. Plummer, Gayther L. (Georgia Univ., Athens). Oct. 1966. 68p.

A five year study of the accumulation of radioisotopes by plants and animals inhabiting the granitic outcrop ecosystems of the Georgia Piedmont was conducted beginning in 1961. Natural and fallout radioactivity was investigated by assaying the granites, soils, some plants, insects, and animals for quantities of radioisotopes. Attempts were made to explain actions and interactions between various radioisotopes, soils, plants, water-flow through communities and concentrations within components of the respective ecosystems. ^{137}Cs, ^{90}Sr, and ^{54}Mn concentrations were of the greatest interest and data on their uptake by plants, insects, and deer are detailed. (L.C.L.)

19760 (TEI-867) GEOLOGY, SOIL, AND CLIMATE AT SPECIFIC POINTS THROUGHOUT THE WORLD. VOLUME II. EUROPE, U.S.S.R., AND SOUTHWEST ASIA. Ruane, Paul J.; Woo, C. C.; Gardner, Louis S.; Newton, Elisabeth G.; Reimer, Allen; Zarza, Ray (Geological Survey, Washington, D. C.). Oct. 1966. 138p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Soil profiles and data on climatic conditions are reported for 47 sites in Europe, the Soviet Union, and Southwest Asia. These sites included 14 in the USSR; 6 in Italy; 5 in England; 4 in Spain; 3 in Germany; 2 each in Austria, Denmark, France, Hungary, Iran, Poland, and Turkey; and 1 in Iraq. The data are to be used in predicting depth of penetration that might result from reentry impact of an aerospace radioisotopic power supply capsule. (F.S.)

19761 FOSSIL ALPHA-PARTICLE RECOIL TRACKS: A NEW METHOD OF AGE DETERMINATION. Huang, W. H.; Walker, R. M. (Washington Univ., St. Louis). Science, 155: 1103-6 (Mar. 3, 1967).

The discovery of a new type of fossil nuclear track in mica is reported. This track is produced by the recoil nucleus accompanying the α-particle decay of uranium and thorium impurities. The tracks are very short and can be seen with phase contrast microscopy. Measurement of fossil α-recoil track densities, coupled with determinations of the thorium and uranium contents, provides a new dating technique analogous to the previously discovered "fission-track method." The primary advantage of the α-recoil method is a several-thousand-fold increase in sensitivity over the fission-track technique. The α-recoil method should also prove useful in studying the problem of extinct isotopes in meteorites. (auth)

19762 RADIUM CONTENT IN PETROLEUM-BEARING WATERS. Dimtchev, T.; Doietchinova, K. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 51-6(1966). (In Russian).

The Ra content of water-bearing nappes of deep drillings in the petroleum deposits of Gigen and Dolmi-Dabnik as well as in the prospection drillings of some other regions was determined. Association with the chemical characteristics of the waters was sought. The Palmer coefficient and that of the Soulin metamorphism was determined. The Ra content of petroleum waters of the Gigen deposit varies from 0.5×10^{-11} to 1.1×10^{-10} g/l. The petroleum waters of the Domi-Dabnik deposit have a much higher Ra concentration at 5×10^{-9} g/l. No relation was established between the Ra concentration and the water mineralization. A relation was established between the Ra concentration and the ionic composition of the water. In the majority of cases it is the cationic composition which is the controlling factor. The presence of sulfate and hydrocarbonate ions probably intensify the adsorption and thus reduces the possibility for alkaline solutions of the layers to wash out the Ra in the capillaries. The limited number of samples did not permit conclusions to be drawn on the modification of the Ra content along the drilled surfaces and in the stratigraphic depths. In a relatively more complex manner from the radiochemical viewpoint the waters of the Aquiferous nappes from the Calcareous complex of the Gigen deposit was characterized. (tr-auth)

19763 EFFECT OF CHELATING AGENTS ON THE MOVEMENT OF FISSION PRODUCTS IN SOILS. Nishita, H.; Essington, E. H. (Univ. of California, Los Angeles). Soil Sci., 103: 168-76 (Mar. 1967).

Chelating agents, ethylenedinitrilotetraacetic acid (EDTA), carboxymethyliminobisethylenitrilotetraacetic acid (DTPA), and ethylenediiminobisohydroxyphenylacetic acid (EDDHA), and deionized water were evaluated as to their ability to move several radioactive fission products ^{89}Sr, ^{91}Y, ^{106}Ru, ^{137}Cs, and ^{144}Ce in different kinds of soils. Different soils exhibited considerable difference in the effectiveness of the various leaching agents. Irrespective of the kind of soil, the order of magnitude of movement by water leaching generally was ^{137}Cs, ^{91}Y, $^{144}Ce < {}^{89}Sr \ll {}^{106}Ru$. Except in one soil (Hanford sandy loam), practically no movement of ^{137}Cs, ^{91}Y, or ^{144}Ce occurred by H_2O leaching. Among the chelating agents, the effectiveness of EDDHA was generally the least, while the relative effectiveness of DTPA and EDTA varied with the soil and radionuclide. The possible causes for the variations in the effectiveness of different leaching agents in different soils were discussed. (auth)

19764 FORMS OF THORIUM TRANSPORT IN HYDROTHERMAL SOLUTIONS. Shcherbina, V. V.; Abakirov, Sh. A. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow. Inst. of Geology, Frunze, USSR). Geokhimiya, No. 2, 239-40(Feb. 1967). (In Russian).

Data on thorium transport in hydrothermal solutions showed that for the two parageneses of thorates in ferrite-bearing deposits, the most probable forms of transport at 250 to 220 to 190°C must be ThF_4^{3-} and $[Th(CO_3)_5]^{6-}$ anions. Moreover, at a certain point in the process the latter anions transform into the first, ThF_4^{3-}. (R.V.J.)

19765 DISCRIMINATING BETWEEN NATURAL AND INDUSTRIAL POLLUTION THROUGH CARBON DATING. Rosen, A. A. (Robert A. Taft Sanitary Engineering Center, Cincinnati); Rubin, Meyer. J. Water Pollut. Contr. Federation, 37: 1302-7(Sept. 1965).

A new radioisotope method employing ^{14}C was developed for distinguishing between industrial and natural organic pollution sources. The method depends on the fact that the sources of readily oxidized organics are primarily biological material: animal and vegetable matter in garbage and wastewater, and decaying vegetable matter in land runoff. These materials are contemporary in their content of ^{14}C, as against the wastes of organic chemical industries based on the use of nonradioactive fossil carbon materials: coal, petroleum, or natural gas. When the organic pollutants are recovered from a stream and dated, the ^{14}C activity reveals the proportion of organic carbon originating in fossil carbon and, therefore, in industrial processes. The sample required for assay of ^{14}C content is obtained by adsorption of organic contaminants from many thousands of gallons of water on a column of active carbon. The principle of the method was demonstrated by application to 3 water supplies in which the pollution sources were known to range from nearly all industrial to predominantly municipal. The utility of the method was also demonstrated by application to 3 additional water sources in which the proportion of industrial and biological contaminants could not be predicted by other means. (BBB)

19766 NEW RADIOCARBON DATE FOR WALES. Brown, M. J. F.; Ellis-Gruffydd, I. D.; Foster, H. D.; Unwin, D. J.

(University Coll. of London). Nature, 213: 1220-1(Mar. 25, 1967).

The results are presented of a radiocarbon age determination on organic material recently found in fluvioglacial deposits exposed in workings at Banc-y-Warren, Cardiganshire. A description is given of these deposits. A discontinuous horizon of peaty organic mud was found some 70 ft below the top of the section, within the gravel layer. The samples were dated as $31,800^{+1400}_{-1300}$ years B.P. The origin of the deposits is discussed. Earlier age determinations are reviewed. (UK)

Meteorology

Refer also to abstracts 19759 and 19760.

19767 (EUR-3165.d,f,i,n) RESULTATS DES MESURES DE LA RADIOACTIVITE AMBIANTE DANS LES PAYS DE LA COMMUNAUTE EN 1965: AIR-RETOMBEES-EAUX. (Results of Environmental Radioactivity Measurements in the Community Countries in 1965: Air-Fallout-Water). (European Atomic Energy Community). Dec. 1966. 54p. (In several languages). Dep. mn.

Results are presented of the measurements carried out in 1965 by the EURATOM member States at the environmental radioactivity monitoring stations, together with certain data obtained at Euratom's Joint Research Centre, Ispra. Measurements of radioactivity in the air at ground level, in fallout, and in water are given. The majority of these measurements relate to total beta radioactivity. The measurement results for certain specific radionuclides are also given, as well as the amount of precipitation observed at fallout sampling stations. Graphs are given to show the pattern followed throughout the year, a comparison being drawn with data from 1962, 1963, and 1964, as well as the situation in 1965 in the United States and Canada. (tr-auth)

19768 (UCRL-50179) COMPUTER PROGRAM FOR CALCULATING THE ATMOSPHERIC DISPERSION OF LARGE CLOUDS. Crawford, Todd V. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 23, 1966. Contract W-7405-eng-48. 58p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A numerical model is presented for predicting the time and space history of cloud concentrations, due to pollutants from explosions, within a coordinate system fixed to the cloud's center. Theories of atmospheric turbulence and diffusion are reviewed and evaluated for applicability to this problem. It is concluded that, if the sampling time is long compared to the characteristic time of the diffusion processes, similarity theories reasonably fit the available data. Similarity theory was used to predict the horizontal diffusion of a cylindrical cloud, but, in the numerical model, vertical diffusivity as a function of cloud height above the ground is a more realistic input. Calculations are presented to show the sensitivity of the calculations to initial cloud size, atmospheric dissipation, vertical diffusivities, and the removal of material from the cloud by deposition velocities. A sample problem is given. (L.C.L.)

19769 USE OF GAMMA-RAY SPECTRA IN AIRBORNE MEASUREMENTS OF GLOBAL FALLOUT CONTAMINATION OF TERRITORIES. Boltneva, L. I.; Dmitriev, A. V.; Kogan, R. M.; Ionov, V. A.; Nazarov, I. M.; Fridman, Sh. D.; Yakovlev, A. F. Izv. Akad. Nauk SSSR, Fiz. Zemli, No. 2, 114-19(Feb. 1967). (In Russian).

An airborne 100-channel γ scintillation spectrometer consisting of a NaI(Tl) crystal combined with FEU-49 photomultiplier was used for measuring γ spectra of the earth's surface contaminated by fission products. Data recorded by the two detectors installed in an AN-2 aircraft and measured at 25 to 100 m over the ground are tabulated. The recent soil contamination γ spectra showed photopeaks of natural and fallout radiation of 0.5 MeV (^{103}Ru + ^{103}Rh and ^{140}Ba + ^{140}La), 0.76 MeV (^{95}Zr + ^{95}Nb); 1.46 MeV (^{40}K), 1.6 MeV (^{140}Ba + ^{140}La), and 0.62 MeV (^{11}C thorium). For the old contamination the spectrogram peaks recorded only 0.66 MeV (^{137}Cs). The relation between ^{95}Zr + ^{95}Nb fallout and the amount of precipitation was also determined. The sensitivity of the γ spectral recording device mounted in an aircraft proved very high. For instance, it was capable of recording the minimum γ doses of ^{95}Zr + ^{95}Nb which were in μCi/km^2 and are equal to ~0.1 μr/h at 1 m elevation. (R.V.J.)

19770 SOME QUESTIONS IN THE STUDY OF NATURAL FOG RADIOACTIVITY. Sopauskas, K.; Vebra, E.; Vebriene, B. (Dept. of Nuclear Physics and Application of Radioactive Isotopes, Vilnyus, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 6: 135-42 (1966). (In Russian).

A method is suggested for simultaneously estimating the radioactivity of air and fog drops. It is shown that under fog and mist conditions high concentrations of natural radioactivity in the atmosphere, conditioned by ground inversions, are observed. The lesser part of the radioactivity is found in the fog drops and the greater part in the air. It is shown that it is possible to estimate the drop-size distribution with the bulk of radioactivity. It is noted that mist drops containing an insignificant quantity of water have more radioactivity than water that is found in the same volume of thick fog. (auth)

19771 STATIONARY VERTICAL DISTRIBUTION OF THE WEIGHTLESS RADIOACTIVE MIXTURE IN THE AIR LAYER NEAR THE EARTH. Jordanov, D. (Geophysical Inst., Bulgarian Academy of Sciences). Compt. Rend. Acad. Bulg. Sci., 19: 591-4(1966). (In German).

Equations describing the stationary vertical distribution of weightless radioactive mixtures in the air layers near the earth are derived. The equations are derived on the assumption of a horizontally homogeneous emitting earth surface and radioactive equilibrium between Rn and its daughter products. (J.S.R.)

19772 PROBLEMS RELATIVE TO THE ISOTOPIC COMPOSITION OF NEON AND ARGON IN NATURAL GASES. Pentcheff, N. P.; Piperov, N. B.; Lilov, P. Compt. Rend. Acad. Bulg. Sci., 19: 603-5(1966). (In French).

The formation of Ne isotopes during spontaneous nuclear processes was investigated by determining the isotopic composition of Ne and Ar in subterranean natural gas sources, that were rich in Ar. The ratio ^{22}Ne/^{21}Ne and ^{40}Ar/^{36}Ar were determined with a relative precision of ±2 to 4%. The data are tabulated for four natural gas sources and compared with results for air. The results indicate that the isotopic ratios are the same in the natural gas and in the atmosphere. It is therefore assumed that there is no supplementary accumulation of the two gases as a result of nuclear processes. (J.S.R.)

19773 PERENNIAL FISSION PRODUCTS FROM RADIOACTIVE FALLOUT IN SUPERFICIAL LAYERS OF MOUNTAIN PASSES. Dimtchev, T.; Manolov, L. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 143-57(1966). (In Russian).

Some results from the analysis of the radioactivity of samples of the permanent snow from the passes on the Massif of the Vitocha, Rila and Pirin were analyzed. The accumulation of relatively high radioactivity in the surface layer of the permanent snow was confirmed by studies made in 1965. The specific β activity of the samples varies from 2.68×10^{-12} to 7.86×10^{-12} Ci/ml. The mean β activity of samples taken at the interior of the accumulation is 2° less or 5.30×10^{-14} Ci/ml. A gradient of this activity, decreasing from the surface toward the interior layers was established and the highest values were found in the first 10 cm of the surface snow layer. The mean level of the β activity at the surface in 1965 is less by an order of magnitude than that established previously in 1962. The β activity at the interior of the accumulation has a low value almost of the same order which is connected with the difference of the degree of general contamination of the atmosphere during the respective years. The β activity of the snow at the interior of the accumulation is in good correlation with the mean radioactivity of the freshly fallen snow. The decay curves of the different samples make it possible to consider these activities as mixtures of fission products composed principally of long lived radioisotopes. The effective half-lives determined were close to that of ^{144}Ce. A spectrometric γ analysis was made of some samples of the surface layer taken in 1963. From the γ spectra the presence of ^{144}Ce + ^{144}Pr, ^{137}Cs, ^{40}K, and ^{214}Bi was established. In order to evaluate the intensity ratio of the decay chains it was assumed that the concentration of natural radioisotopes is insignificant or almost zero in comparison with the concentration of the fission products ^{144}Ce + ^{144}Pr and ^{137}Cs. A procedure for the fast approximate evaluation of the ratio of the β activity of these isotopes beginning with the determination of the size of their photo points in the γ spectra was examined. The ratio determined in this manner of the β activities of ^{144}Ce and ^{137}Cs is 21.7 taking into consideration a total error for the procedure of 15%. It was established that this ratio is almost constant for different samples taken from the surface of the snow. The character of the γ spectra and of the decay curve of different samples is always the same. It is assumed that the permanent accumulation of the fission products of radioactive fallout originating from the global contamination of the earth's atmosphere results from the complex action of a series of factors of local character. (tr-auth)

19774 EVOLUTION OF THE CONCENTRATION OF RADIOCARBON IN THE LOW LATITUDES OF THE NORTHERN HEMISPHERE DURING THE LAST NINE YEARS. Tamers, Murry (Venezuelan Inst. of Scientific Investigation, Caracas). Compt. Rend., Ser. B, 264: 344-7(Jan. 23, 1967). (In French).

The recent changes of the ^{14}C content established in plants of Venezuela are due to the contamination of the atmosphere by nu-

clear arms testing. Tree leaves were used as samples to observe the general evolution of these variations during the course of the last nine years. The comparison of the results obtained with those obtained in the temperate zones show that the dissipation of artificial ^{14}C is considerably more rapid in Venzuela. This is explained by the passage of the south equatorial marine current in which the CO_2 is rapidly exchanged with that of the lower air levels. The concentration of artificial ^{14}C in other countries in the lower latitudes of the northern hemisphere are also examined. (tr-auth)

Mineralogy

19775 CARBON ISOTOPE COMPOSITION OF CARBONACEOUS MATTER FROM THE PRECAMBRIAN OF THE WITWATERSRAND SYSTEM. Hoefs, Jochen (Univ., Goettingen, Ger.); Schidlowski, Manfred. Science, 155: 1096-7(Mar. 3, 1967).

Polymerized hydrocarbons occurring in the gold-uranium conglomerates of the Witwatersrand System (South Africa) show δC^{13} values between −22.4 and −32.8 per mill, their isotopic composition thus falling into the range of sedimentary organic carbon. Accordingly, organic derivation of the material seems very probable. This conclusion is consistent with a model of the existence of organic evolution and biologic activity in times certainly older than 2.15×10^9 years. (auth)

19776 VERTICAL DISTRIBUTION OF URANIUM, THORIUM, AND POTASSIUM IN THE CONTINENTAL CRUST. Lambert, I. B.; Heier, K. S. (Australian National Univ., Canberra). Geochim. Cosmochim. Acta, 31: 377-90(Mar. 1967).

Granulite facies rocks exposed at the earth's surface may not be representative of the lowermost parts of the continental crust, but they provide samples of the deepest levels made available in any areal extent at the surface. A concentration–depth relation for elements can thus be defined by statistically comparing their abundances in granulite facies rocks with their abundance in the common surface rocks. U, Th, and K have been determined in approximately 400 rocks from the Australian shield. Felsic amphibolite facies gneisses have U and Th contents indistinguishable from those of hornblende granulite subfacies rocks and intrusive shield granites. Pyroxene granulite subfacies rocks of similar bulk chemical composition have significantly lower abundances of U and Th. In the mafic rocks studied the U and Th contents and Th/K and U/K ratios show no variation with metamorphic grade. The lower U and Th concentrations in felsic pyroxene granulite subfacies rocks are related to processes of metamorphism, including partial melting and upward movement of granitic material and vapour. The overall average contents of Th and K in the surface rocks of the West Australian basement shield appear to be similar to the overall average contents of these elements in the Palaeozoic rocks outcropping in East Australia. However, the shield seems to be depleted in U relative to the younger orogenic region. It has been calculated that the surface heat production of the shield is only about 25 per cent less than that of the Palaeozoic rocks. This is compared with the difference of about 60 per cent in the average heat flows measured in the two regions. (auth)

Oceanography

19777 ^{18}O VARIATIONS IN SULFATE IONS IN SEA WATER AND SALINE LAKES. Longinelli, A.; Craig, H. (Univ. of California, San Diego, La Jolla). Science, 156: 56-9(Apr. 7, 1967).

A new method measures the oxygen-isotopic composition of dissolved sulfate ions and barium sulfate. Sulfate ions in the oceans are enriched in ^{18}O by 9.5 per mille relative to mean ocean water and show only minor variations, probably because the exchange rate with water is slow enough to prevent local equilibrium with surface waters. Sulfate ions in saline lakes and brines have ^{18}O enrichment of from 7 to 23 per mille relative to mean ocean water; the value of the highest enrichment observed is about the same as that of atmospheric oxygen. (auth)

19778 STUDY OF THE RADIOACTIVITY OF THE WATERS OF THE WESTERN MEDITERRANEAN BY GAMMA SPECTROMETRY IN SITU (1961–1962). Chesselet, Roger; Nordemann, Daniel (CEN, Saclay, France. CNRS, Gif-sur-Yvette, France). Bull. Inst. Oceanogr., 60: No. 1266, 1-14(Sept. 1963). (In French).

In situ γ spectrometry is a method for the direct detection and measurement of natural or artificial γ emitter nuclei in sea water. Applications of the method during experiments made in the Mediterranean Sea (July 1961 and August 1962) are discussed. The performance of the equipment is discussed. The counting rate for a γ emitter uniformly distributed in an infinite medium surrounding the detector, is 32 counts per hour/$\mu\mu$Ci/l (photoelectric detection of potassium-40). Sensitivity has been recently estimated at 2 $\mu\mu$Ci/l. The γ spectra obtained during these cruises were analyzed. Concentrations in sea water of zirconium-95–niobium-95 have been measured at different oceanographic stations. Values between 2 $\mu\mu$Ci/l and 8 $\mu\mu$Ci/l have been found from 100 meters to 0 meter for depth of detector location. Fallout zirconium-95–niobium-95 for the Mediterranean basin, measured from fallout samples from October 1961 to July 1962 is in complete agreement with these concentrations in sea water. (tr-auth)

Seismology

Refer also to abstract 19786.

19779 (AD–640842) AN EVALUATION OF A METHOD FOR FOCAL-DEPTH DETERMINATION OF SEISMIC DISTURBANCES FROM UNDERGROUND NUCLEAR EXPLOSIONS. Lin, Jin-long (Pennsylvania State Univ., University Park. Dept. of Geology and Geophysics). July 15, 1966. Contract AF19(628)-238. 109p. (AFCRL–66-570). CFSTI $3.00 cy, $0.65 mn.

The Watson-Merdler method for determination of focal depths was applied to fourteen seismograms from underground nuclear explosions. Because the depths for blasts are less than 1 km, the true time Δt for the actual surface reflection was not tested. Two hundred cases where concentration ratio, C_R, was greater than in the original seismogram and where the area under the seismogram was reduced were investigated. Causes which can produce simplification are: deconvolution removes the pP sequence from the seismogram, deconvolution removes PcP or some other sequence other than pP, deconvolution produces a larger maximum amplitude in the deconvoluted seismogram than in the original, deconvolution diminishes amplitudes on the seismogram, and deconvolution phases random noise so as to add to or subtract from the principal peaks of the seismic pulse. The doublet-function hypothesis for a seismogram is too simple and is therefore unrealistic. The simplicity criterion may identify many pulses in addition to the pP pulse on the seismogram. The Watson-Merdler method does not show promise to distinguish blasts from earthquakes. (TAB)

19780 (VUF–3014) EARTH VIBRATIONS FROM A NUCLEAR EXPLOSION IN A SALT DOME. Project DRIBBLE, SALMON Event. Final Report. Mickey, W. V.; Lowrie, L. M.; Shugart, T. R. (Coast and Geodetic Survey, Rockville, Md.). Mar. 17, 1967. 166p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Recorded earth particle motions in terms of displacements, velocities, and accelerations were near predictions in the distance range of 1.5 to 603 km for the 5 kt SALMON nuclear detonation in a Mississippi salt dome. These motions included measurements from nearby cities and industrial facilities. Scaled earth motions from HE detonations of 500 to 4000 lb in the unconsolidated shallow sediments were consistently higher than the motions recorded from SALMON. Asymmetric seismic energy propagation was observed with more efficient propagation to the north and south. Apparent velocities of the first arrivals were: 1.458 to 6 km from ground zero, east 2.82 km/sec, south 2.67 km/sec; 6 to 100 km, 4.77 km/sec; and 100 to 630 km southwest, 8.5 km/sec. The maximum motions were propagated at near 1.9 km/sec. The horizontal resultant vector for first motion was anomalous for three stations with deviations from a radial path of 36.2° to 66°. Equivalent earthquake magnitude from calculated seismic energies was near 5.1 with a source-seismic energy ratio of 0.47 percent. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 19768 and 19774.

19781 (AD-640595) RADIANT EXPOSURES FOR IGNITION OF TINDER BY THERMAL RADIATION FROM NUCLEAR WEAPONS. Progress Report (Final). Report No. 9400-12. Bracciaventi, J.; Heilferty, R.; Derksen, W. (Naval Applied Science Lab., Brooklyn, N. Y.). July 5, 1966. 112p. CFSTI $3.00 cy, $0.65 mn.

The radiant exposure to ignite tinder materials for thermal radiation from nuclear weapons was measured. The experiments involved 41 materials commonly encountered in urban areas and are to provide basic data of direct use in the determination of fires caused by nuclear weapons and to provide basic information for ignition prediction models. The radiant exposures for ignition of the most susceptible common material, newspaper (dark picture) ranged from 5.1 cal cm (-2) to 31 cal cm (-2) for bursts of 20 kt to 100 Mt respectively. Black roll roofing, a common material representing an important but less susceptible fuel, ignited at 38 cal cm (-2) for a 1 Mt pulse and 45 cal cm (-2) for a 10 Mt pulse. Other thin fuels ignited at various intermediate or higher exposures. Thick wood fuels, such as might be used as building siding, were ignited to sustained flaming by the simulated detonation pulses. Cedar shingle was ignited at 15 cal cm (-2) by a 1 Mt pulse, and at 26 cal cm (2) by a 10 Mt pulse. (TAB)

19782 (NVO-22(Rev.1)) STUDY RELATED TO REPORTS OF DAMAGE FROM THE SALMON EVENT, PROJECT DRIBBLE. (Holmes and Narver, Inc., Las Vegas, Nev. On-Continent Test Div.). Mar. 1967. Contract AT(29-2)-20. 73p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

On October 22, 1964, a coupled 5 kt nuclear device was detonated at a depth of approximately 2,700 feet in the Tatum Salt Dome, 23 miles from Hattiesburg, Mississippi. This detonation called the Salmon Event was one of the planned detonations of Project Dribble of the Vela Uniform Program. After the Salmon detonation, minor damage to structures was unexpectedly reported from areas far removed from surface zero. An investigation to determine whether the Salmon Event had caused damage to structures in areas beyond the predicted range of damage and to provide a supportable explanation for the cause of damage, if real damage had been ascertained, is reported. Prior to the Event predictions were made of the ground motions to be expected at different distances from surface zero. These ground motion predictions, when related to the generally accepted threshold of minor damage to plaster, indicated that the limit of minor damage to structures would be at 4.5 miles from surface zero. The criterion used for threshold of minor damage to plaster was based on earlier experiments with chemical explosions by other organizations. Guided by these pre-shot studies, existing structures with 4.5 miles of surface zero were surveyed and strengthened to prevent structural damage. It was concluded that newly formed minor damage to structures did occur beyond the predicted limit for damage of 4.5 miles and damaged structures were observed as far as 25 miles from surface zero, and in some cases the damage to these structures was caused by the Salmon Event. It was found that damage to structures exceeding 4.5 miles from ground zero was caused by the following: variations of transmission of seismic energy in certain directions was due to subsurface geology peculiar to the region, the peak value of ground motion as a criterion for predicting damage to the most susceptible structures was overestimated, and the current concept of a general threshold of damage expressed in terms of the maximum excursion of a ground motion parameter was found to be unsuitable for application in the Salmon Event. (auth)

19783 (NVO-38-9) PERMEABILITY REDUCTION AND WALL STABILIZATION OF LARGE-DIAMETER DRILLED HOLES. Schoeppel, Roger J.; Chandler, William A.; Dellinger, Thomas B. (Fenix and Scisson, Inc., Tulsa, Okla. Petroleum Consultants, Houston, Tex.). May 1966. Contract AT(26-1)-38. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The techniques used for drilling large-diameter holes for subsurface emplacement of nuclear devices at the Nevada Test Site are effective in cutting and moving to the surface a large mass of rock. Unusual conditions are encountered, however, where the permeability and instability of rock adjacent to the borehole markedly reduce drilling efficiency. Three conditions related to either environment or drilling technique which reduce effectiveness are: reduced capability of the air circulating system to remove cuttings due to loss of air to surrounding formations, abnormal air requirements to remove cuttings due to a large influx of water into the borehole, and sloughing due to borehole wall instability and adverse drilling conditions. Field-developed and proposed remedial measures are reviewed for their overall significance. Procedures to restrict water influx are awaiting trial. Evidence exists that drilling techniques may be partially responsible for hole sloughing problems. Recommendations for future work are based primarily on this premise. (auth)

19784 (TEI-868) LOCATIONS OF POTENTIAL INTEREST FOR FRACTURING OIL SHALE WITH NUCLEAR EXPLOSIVES FOR IN SITU RETORTING, PICEANCE CREEK BASIN, RIO BLANCO COUNTY, COLORADO. Ege, John R. (Geological Survey, Denver, Colo.). Feb. 1967. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Includes Drawings.

Analysis of oil assays, structure sections, and isopach maps of the Parachute Creek Member of the Green River Formation indicates that numerous locations in the western part of the Piceance Creek basin could be selected with an oil shale section at least 500 feet thick that contains not less than 20 gallons per ton of shale oil, and has at least 800 feet of overburden. (auth)

19785 (UCRL-12065(Pt.2)) LABORATORY VERIFICATION OF EXPLOSION CALCULATIONS. PART II. Hearst, Joseph R. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 31, 1966. Contract W-7405-eng-48. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A small-scale "row-charge" experiment was performed with three 2-cm high-explosive charges 9 cm apart on centers and 12 cm below the surface of a tank of the very viscous fluid polyisobutylene. Interaction of the cavities was studied, and cavity growth, free surface motion and pressure versus time were compared with the results of a calculation with the two-dimensional hydrodynamic elastic-plastic computer code TENSOR. Agreement was good except for pressure. Motion of the material between adjacent charges was studied to investigate whether a "row charge" could be approximated by a horizontal cylindrical charge. The approximation is poor. (auth)

19786 (UCRL-14464) SEISMIC COUPLING OF UNDERGROUND NUCLEAR EXPLOSIONS. Springer, Donald L. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 20, 1965. Contract W-7405-eng-48. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Seismic amplitude data for underground nuclear explosions are correlated with detonation energy. Amplitudes are reproducible to 25 percent when source media and propagation path differences are minimized. These data verify theoretical scaling relationships and establish relative coupling for various shot media. An empirical correlation of these amplitude data with dry porosity of the detonation medium indicates that a medium with 60 percent dry porosity may couple explosive energy one-fourth or one-fifth as efficiently as does alluvium. The relationship of teleseismic magnitude to explosive yield for various types of low coupling shows that dry porous media may be a significant means of preventing the detection of seismic signals generated by underground nuclear explosions. (auth)

19787 (UCRL-14729) GAS EQUATION OF STATE FOR NATURAL MATERIALS. Butkovich, T. R. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 24, 1967. Contract W-7405-eng-48. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Gas equations of state have been developed for materials in which nuclear detonations have occurred; H_2O, NaCl, and silicate rocks. For silicate rocks, a simple silicate approximation was used; the rock gas was assumed to consist of SiO_2 plus varying amounts of H_2O by weight. The model assumed SiO_2 + 1% H_2O constituted dry rock, SiO_2 + 10% H_2O constituted partially saturated rock, and SiO_2 + 20% H_2O constituted a fully saturated porous rock. The materials are treated as a perfect gas of molecules and ions to temperatures of about 3 eV (1 eV ≃ 11,600°K) and less than normal density. Above this temperature the gas is described in terms of atoms and ions up to the point where it is completely ionized and consists of nuclei and free electrons. Above normal density, the shock Hugoniot equation of state was used. Expansion adiabats were calculated for the various gases, using a number of simplifying assumptions. Also the relationships between the amount of material vaporized and the energy yield were obtained. From data on a number of contained nuclear explosions, relationships between measured cavity volume and overburden pressure were obtained. These relationships show that for contained explosions the cavity expands until its pressure equals some factor greater than the overburden pressure ρgh, depending on the material. This factor

varies from 1.3 to 2.3, and indicates that the material outside the gas maintains a residual shear strength. (auth)

19788 EFFECTS OF NUCLEAR EXPLOSIONS AT HIGH ALTITUDE ON SHORTWAVE COMMUNICATIONS. Schaedlich, A. Fernmelde-Praxis, 41: 509-12(1964). (In German).

Recently the results of studies made in 1962 of the effects of nuclear explosions have been made available. Transmission on wavelengths of 5000, 7190, 9570, 11710, 11725, 11740, 11810, 12730, and 15280 MHz were studied after an atomic bomb of 1.5 megatons was exploded on the morning of July 9, 1962 at 5 o'clock. The erase effect was observed in these wavelengths only when they crossed the test area and only in explosions at high altitude of bombs of more than 1 megaton. The loss of signals was not complete at the instant of detonation, so that test signals remained audible. The after effects of the erase effect lasted up to 2 days at 11710 MHz, but at 7190 they were negligible. The impairment of propagation of short waves was more pronounced at higher altitudes. It was not possible to ascertain from the test whether the weather could be influenced by an atomic explosion, but it was evident that very large explosions at high altitudes could affect the conditions of ionospheric propagation in the vicinity of the explosion. (BBB)

19789 A SURVEY OF COMPLAINTS OF SEISMIC-RELATED DAMAGE TO SURFACE STRUCTURES FOLLOWING THE SALMON UNDERGROUND NUCLEAR DETONATION. Power, Dean V. (Univ. of California, Livermore). Bull. Seismol. Soc. Amer., 56: 1413-28(Dec. 1966). (UCRL-14110(Rev.1)).

Following the 5-Kt Salmon underground nuclear experiment in Mississippi, many unexpected complaints of damage were received from residents living 15 to 40 Km distant. The claimed damage was mostly cracks in plaster, stucco, and masonry. Ground motion at these ranges was within the predicted safe limits, with peak surface-particle velocities roughly an order of magnitude below the 5 to 10 cm/sec level previously accepted as the threshold for damage. It is shown that a 5 cm/sec damage threshold does not apply to this area, and revised damage criteria need to be formulated that take into consideration geology, frequency spectrum, and other factors in addition to surface particle velocity. The claimed damage was similar to that normally found in Mississippi homes and attributed to poor foundation soils. The triggering by the Salmon detonation of naturally occurring settlement cracks is suspected, but the physics of the process is not yet fully understood. (BBB)

Facilities and Equipment

Refer also to abstracts 19783, 19984, 20805, 20809, 20876, 20879, 20901, 20948, and 21092.

19790 (BAW-1280-42) ANALOG SIMULATION OF SODIUM-HEATED STEAM GENERATOR. Progress Report. Research Report No. 5132. Iyer, J. S. (Babcock and Wilcox Co., Alliance, Ohio. Research Center). Jan. 31, 1967. Contract AT(11-1)-1280. 105p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress in developing a mathematical model to describe the dynamic performance of the 30 MW(t) prototype sodium-heated steam generator is discussed. This project will produce information of importance in applying the sodium-heated steam generator to either a thermal or fast breeder-type reactor plant. A model having a constant heat transfer coefficient at each load has been completely debugged at each of five different load points. The steady state results of the dynamic model were compared with predicted steady state design performance, and found to be in good agreement. The dynamic response of the model was obtained at 100% load using actual installed areas of the prototype. Step perturbations were studied for variations in the flow and temperature of the feedwater, sodium, and spray. The effects of each of these variables on the flow and temperature of the main stream, the boiler outlet, and the sodium outlet were recorded. Recommendations are made for refining the present model and for applying it to the study of the operation of the full scale generator. (L.C.L.)

19791 (BDX-613-76) TEST EQUIPMENT ACCURACY. Winkler, Glenn D. (Bendix Corp., Kansas City, Mo.). Nov. 18, 1965. Contract AT(29-1)-613. 11p. (CONF-651124-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Institute of Electrical and Electronics Engineers, Mid-American Electronics Conference, Kansas City, Mo.

Sources of errors, tolerances, and the overall accuracy of test equipment are discussed. (L.C.L.)

19792 (CONF-660511-, pp 8,5,1-12) CAPSULE IRRADIATION EXPERIMENTS AT CHALK RIVER. Boyd, A. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario)).

Irradiation capsule experiments and associated instrumentation used at Chalk River are described. Novel capsule designs are described for measuring creep of Zr alloys, and pressure in fuel capsules, thermoelectric fuel element capsules, organic coolant irradiation capsules, and capsules for fission yield measurements. Adiabatic calorimeters, absorbers, and detectors are described. New instrumentation described includes adiabatic flux determination and control. Fabrication of capsule components is discussed. (F.S.)

19793 (CONF-660511-, pp 8,1,1-30) BURST IRRADIATION FACILITIES AT THE NATIONAL REACTOR TESTING STATION AND A REVIEW OF THE SUBASSEMBLY TESTING PROGRAM.

The Burst Irradiation Facilities including its two reactors, the Power Burst Facility and the Capsule Driver Core, are described. The facility was designed and constructed to study fuel element failure thresholds and failure mechanisms, heat transfer processes and physical characteristics bearing on failure mechanisms, chemical reactions which can yield additional energy, pressure wave shock phenomena and water hammer resulting from thermal-to-mechanical energy conversion, and the type and amount of fuel dispersed and fission products released by failure. It was concluded that although fuel-system destructive tests are necessary to confirm the expected behavior of integral reactor systems under accident conditions, the study of destructive processes can be more efficiently done first in small-scale capsule or subassembly tests. (F.S.)

19794 (CONF-660511-, pp 8,2,1-20) DEVELOPMENT OF CAPSULES AND LOOPS FOR DYNAMIC PRESSURE CONTAINMENT.

Behavior of potential capsule materials in a dynamic pressure environment was investigated. The development of a filter is described for damping out transient pressures propagated through in-pile loops to protect pumps and other loop hardware in the Power Burst Facility experiments. Extra low-carbon stainless steel test cylinders were found to possess greater strength in an explosive environment than steel cylinders with higher carbon content. An expansion chamber, to attenuate high-frequency pressure pulses, and a series of air-expansion volumes to attenuate low-frequency pressure pulses, were tested in conjunction with the development of a transient pressure filter for an in-pile loop facility. (F.S.)

19795 (CONF-660511-, pp 7,1,1-52) HEATERS FOR IRRADIATION EXPERIMENTS. Hancock, N. H. (Atomic Energy Research Establishment, Harwell (England)).

Resistance heaters of mineral-insulated cable form have been manufactured and developed to a high standard, and the further development to extend their working temperature up to 1200°C by the use of refractory and noble metals is detailed. A range of bare metal, ceramic and cermet heaters is being investigated for continuous operation in reactor experiments at about 1600°C. Laboratory tests have established useful data on high-temperature compatibility, grain growth, evaporation and oxidation rates in inert gas atmospheres. Design data and experience are presented for both induction and low-voltage resistance heating, these systems having been applied to a number of reactor engineering experiments. Heat transfer work involving surface heat fluxes in excess of 400 watts/cm^2 has required the development of a heat source more powerful and reliable than a resistance heater; some U.K.A.E.A. work on a thermionic device for this purpose is described. (auth)

19796 (CONF-660511-, pp 7,2,1-5) USE OF NOBLE AND REFRACTORY METAL THERMOCOUPLES IN EXPERIMENTAL IRRADIATION EQUIPMENT. Hancock, N. H. (Atomic Energy Research Establishment, Harwell (England)).

For the measurement of temperatures above 1000°C in reactors, noble or refractory metal alloy thermocouples are most commonly used. Some of the advantages and disadvantages of the platinum and tungsten alloys are stated and the irradiation experience at A.E.R.E. Harwell is summarized. (auth)

19797 (CONF-660511-, pp 6,3,1-15) GAMMA THERMOMETER. Schreiber, R. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.).

A γ thermometer is described which is used to determine the irradiation embrittlement of steel. The thermometer consists of a rod ⅛ in. dia and 3 in. long of the material from which the irradiation specimens are made. An inch from one end is a section of slightly larger dia which is force fitted into a stainless steel collar. The collar provides a path for heat generated in the rod to be conducted to the coolant. Penetrations in the collar permit thermocouples to be attached at each end and at the center of the enlarged section of the rod making it possible to measure temperature differences as well as actual temperatures. The γ thermometer measures in-core γ heat, transient thermal properties of reactor structural material, effects of irradiation on thermal conductivity, and spacial power oscillations in large reactor cores. (F.S.)

19798 (CONF-660511–, pp 4.2.1-54) DEVELOPMENTS IN IRRADIATION CAPSULE TECHNOLOGY AT GENERAL ATOMIC. Carpenter, F. D.; Barner, J. O.; Spillane, B. B.; Wallace, W. P. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The nuclear irradiation behavior of reactor materials is of prime importance in the development of nuclear power systems. The development of high-fuel-temperature power reactors requires experimental devices for irradiation of materials at high temperature. Approaches taken to evaluate and design test capsules for use in nuclear development programs are described. Improvements in capsule technology and assemblies associated with capsule design are discussed as well as a specific design associated with a broad, high-temperature controlled irradiation capsule. (auth)

19799 (CONF-660511–, pp 4.3.1-8) CAPSULE DESIGN FOR THE IRRADIATION OF EIGHT FUEL SPECIMENS AT EACH OF THREE TEMPERATURES. Miller, Neil E. (Battelle Memorial Inst., Columbus, Ohio).

A capsule was designed for the evaluation of the fission-gas-retention properties of coated fuels as a function of temperature to high burnup. As many as eight different types of fuel materials can be irradiated at one time in three different temperature zones. Graphite was used for the fuel container and high temperature structural material. (F.S.)

19800 (CONF-660511–, pp 4.4.1-12) IRRADIATION CAPSULE DESIGN FOR OPERATION TO 2000 C. Zielenbach, William J. (Battelle Memorial Inst., Columbus, Ohio).

The development of an irradiation capsule which is capable of withstanding specimen cladding temperatures of 1600 to 2000°C is described. Such factors as heat transfer, thermocouple location, and structural integrity were studied to obtain an irradiation capsule system with maximum utility. (F.S.)

19801 (CONF-660511–, pp 4.5.1-13) DESIGN OF AN IN-PILE CAPSULE POSITIONING MECHANISM. Sleigh, J. H.; Godsin, W. W.; Ream, J. T. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The design, fabrication, and testing of a device capable of automatically and remotely adjusting the position of irradiation capsules in the NASA Plum Brook Reactor Facility are described. The latitude of movement covers a thermal neutron flux range of about a factor of 10. This device, is mated to a 9" O.D. cylindrical vertical test tube facility, and consists of a hydraulic cylinder with its shaft directly coupled to a movable carriage supported by bearings on steel tracks. Reactor primary water serves as the hydraulic fluid for the system and motion is initiated by signal from a temperature recorder monitoring selected capsule thermocouples. Fail safe automatic and manual control features provide fuel temperature control with or without personnel attendance. (auth)

19802 (CONF-660511–, pp 4.6.1-7) IN-CORE VERTICAL ADJUSTABLE FACILITY FOR CAPSULE IRRADIATIONS IN THE NASA PLUM BROOK REACTOR. Gregory, T. L. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.).

A remotely controlled, economical, electromechanical device is described for the movement of an irradiation capsule in the in-core position of the NASA Plum Brook Reactor to allow a maximum of ten inches of vertical movement with respect to the core. Position in relation to the core is measured by a position-indicating transducer mounted outside the pressure vessel on the drive unit. (F.S.)

19803 (CONF-660511–, pp 4.7.1-8) DESIGN OF A FLUX POSITIONING CAPSULE FOR USE IN THE VERTICAL THIMBLES OF THE CP-5 REACTOR. Beck, W. N. (Argonne National Lab., Ill.).

A telescoping tube assembly permits remote positioning of an instrumented irradiation capsule within the vertical thimble of the CP-5 reactor. The assembly may be moved from the midplane of the reactor core to a position three in. above the fueled portion of a reactor fuel element. The assembly has a total travel of 15 in. and is manually operated from the top of the reactor. The assembly is used to control irradiation specimen temperature as well as a means of flux mapping fuel tubes. Temperature control of the capsule has to be adjusted only when a change is made in the core loading or if a transfer or replacement of absorbers is made. (F.S.)

19804 (CONF-660511–, pp 4.8.1-9) AUTOMATED POWER AND PRESSURE CYCLING SYSTEM FOR ELEVATED TEMPERATURE FOR IRRADIATION OF THIN CLAD FUEL PINS. Schreiber, R. E.; Kemmerer, A. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.).

An automated power and pressure cycling system is described which provides a flexible arrangement for performing endurance tests of thin clad fuel pins. The system permits automatic cycling of temperature, pressure, and power independently in fuel-bearing instrumented capsules. Temperature and pressure levels are those of interest in fast and superheat reactors, as well as conventional water reactors. (F.S.)

19805 (CONF-660511–, pp 4.10.1-21) IN-PILE PROPERTIES OF REACTOR FUELS BY OSCILLATING TECHNIQUES. Carroll, R. M.; Sisman, O. (Oak Ridge National Lab., Tenn.).

Oscillating techniques are used in measuring physical properties of reactor fuels during reactor operation. The oscillating experiments were conceived to develop a mathematical model for the defect-trap theory for fission-gas release during irradiation and for analyzing mathematical expressions which contain too many variables to be analyzed by steady state experiments. (F.S.)

19806 (CONF-660511–, pp 5.2.1-17) DESIGN, DEVELOPMENT, AND OPERATION OF A NaK FILLED NATURAL CONVECTION CIRCULATING CAPSULE. Knight, F. W.; Pfefferlen, H. C.; Leyse, R. H. (General Electric Co., San Jose, Calif. Atomic Products Div.).

The design, development, and operation of NaK-filled capsules for the irradiation of fuel elements for fast, ceramic-fueled, sodium-cooled reactors are described. The capsules are to be used to study fission product plugging as well as fuel and clad performance in a high-power fuel element. The capsule was designed to prevent gas blanketing and burnout of the fuel. (F.S.)

19807 (CONF-660511–, pp 1.8.1-22) IRRADIATION SYSTEM FOR CRYOGENIC EXPERIMENTS IN THE PLUM BROOK REACTOR. Haley, F. A.; Wyer, R. R. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

An irradiation system is discussed which consists of an experiment capsule assembly for holding experiment packages, an insertion system for placing of the experiment capsule in the Plum Brook Reactor (PBR), a data acquisition system for recording experiment data and controlling the experiment, and a cryogenic helium system for cooling and actuating experiments. In addition to the irradiation system, a brief description of the PBR is included. (auth)

19808 (CONF-660511–, pp 1.2.1-73) DEVELOPMENTS IN IRRADIATION CAPSULE TECHNOLOGY. Millies, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires).

Standardized French in-pile irradiation capsule designs are described, including Chouca Band D, HF 3 and 5, HEBE, and Cyrano. Chouca B is designed for the irradiation of structural and fissile material in swimming pool-type reactors over a temperature range of 150 to 900°C. Chouca D is designed for the irradiation of structural materials of fuels at temperatures of 150 to 900°C in high flux reactors. This capsule is equipped for high heat removal and requires very high power auxiliary electric heaters. The HF 3 is designed for the irradiation of material specimens from 1000 to 2000°C in a thermal neutron flux of 5×10^{13} n/cm^2/sec. The HF 5 is used in the irradiation of structural fissile materials at very high temperatures and high burnups. HEBE is designed for the irradiation of structural materials in swimming pool reactors over a controlled temperature from 350 to 1400°C. The Cyrano is designed for irradiating fissile materials at core temperatures and power levels equivalent to power plant conditions. (F.S.)

19809 (GEMS–2048-1(Vol.3)) 250-WATT RADIOISOTOPE THERMOELECTRIC POWER SYSTEM. VOLUME III. Final Report, June 30, 1966–December 31, 1966. McCarty, L. H. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Contract AT(29-2)-2048. 211p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The technical description of the ground handling and support equipment for the 250-Watt Power Supply System is presented. Also included is the rationale employed in selecting the reference design from a number of alternatives considered, and a detailed description of the Sr-90 fuel loading procedure. The ground handling and support equipment is considered in two categories, ground handling and aerospace ground equipment. The ground handling equipment comprises all the equipment associated with handling and installation of the radioactive fuel load. The aerospace ground equipment comprises all of the support equipment associated with the assembly, handling, servicing and check out of the unfueled power supply system. The equipment design is compatible with the power supply system requirements and with the Titan III launch facilities at Cape Kennedy. Modifications to these launch facilities must be kept to a minimum. In addition, consideration must be given to use of this equipment at the Titan III launch facilities at Vandenberg Air Force Base. A description of both launch facilities is presented. The 250-Watt Power Supply System consists of a radioisotope thermoelectric generator with

integral re-entry protection and a controlled intact re-entry package with equipment to separate, deorbit and reenter the radioisotope thermoelectric generator. Since the 250-Watt Power Supply System is not designed for a specific spacecraft, a number of orientations are possible within the standard payload envelope. Because of the shape of the power supply system and the location of the radioactive fuel at one end, it seems most logical to install the power supply system vertically, with the radioisotope thermoelectric generator up. Such an installation leaves the maximum available volume in a convenient shape for the proper payload. In addition, this arrangement places the radioactive fuel as far as possible from the payload, with the bulk of the power supply system interposed. (auth)

19810 (K-1686) PROTECTIVE SHIPPING PACKAGES FOR 30-INCH-DIAMETER UF_6 CYLINDERS. Mallett, A. J.; Newlon, C. E. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Apr. 13, 1967. Contract W-7405-eng-26. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two designs which appeared suitable as standard protective packages for Class II shipment of 30-in. dia × 81-in. cylinders containing moderation controlled uranium hexafluoride were developed at the Oak Ridge Gaseous Diffusion Plant. One is a horizontal loading unit comprising symmetrical separative top and bottom sections; the other is a cylindrical, end loading unit. A phenolic high-temperature foam plastic with fiber glass additive is used as a structural and fire-resistant material between the inner and outer casings of each unit. Both of the protective package designs have received AEC and ICC approval for Class II shipments of UF_6 enrichments to 4.5%. Based on the nuclear evaluation, ten of the filled packages may be transported together. (auth)

19811 (LA-DC-8592) EXPLOSION SUPPRESSION BY ROOM INERTING. Penland, J. Robert (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 5p. (CONF-670201-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on the Impact of Low Cost Nuclear Power and Chemical Industry, Houston, Tex.

Room inerting tests were conducted for hydrogen explosion suppression under controlled conditions in a small volume room. Preparations for the tests included sealing the building with grout and caulking compounds; windows were locked and sealed; doorways were sealed with gaskets and weather stripping; inner walls and ceilings of the metal buildings were sprayed with polyurethane to a thickness of 3 to 4 in.; overpressure protection was obtained by a system of pneumatically operated louvers. Double neoprene boots were used in thermal load protection of the hydrogen pipes. Nitrogen was introduced until the oxygen content dropped to 3%. When the oxygen content increases to 5%, nitrogen is again introduced until the oxygen content is reduced to 3%. (F.S.)

19812 (ORNL-TM-1745) INSTRUCTIONS FOR BUILDING A HOMEMADE LARGE-VOLUME SHELTER-VENTILATING PUNKAH-PUMP. Kearny, Cresson H. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The materials and instructions required for building a large-volume shelter-ventilating punkah-pump are described in detail. These instructions were written and tested to enable untrained persons to make pumps which would adequately ventilate shelters from commonly available household materials. (L.C.L.)

19813 (SC-CR-66-2114) EXPERIMENTAL STUDIES OF THE TRANSIENT STRENGTH-DEFORMATION CHARACTERISTICS OF SOIL. Progress Reports Nos. 1-5. Larew, H. G. (Virginia Univ., Charlottesville. Div. of Civil Engineering). Aug. 1966. Contract AT(29-1)-789. 65p. (CE-4877-101-66). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The dynamic stress-deformation characteristics of soil in simple shear devices are described. Following an extended period of experimental study, it was concluded that the first model (Model I) simple shear device would not develop the desired simple shear deformation patterns. However, after a short period of experimentation, it was learned that the Model II simple shear device could be modified to produce the desired deformation patterns. Quasi-static calibration runs were completed with the Model II device and dynamic calibration runs are scheduled. (auth)

19814 (SC-DC-67-1534) COMPARISON AND EVALUATION OF THE HELIUM PRESSURIZATION AND RADIFLO METHODS OF LEAK RATE DETERMINATION. Ford, L. M. (Sandia Corp., Albuquerque, N. Mex.). Mar. 1967. Contract AT(29-1)-789. 10p. (CONF-670405-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 21st Annual Technical Conference of The American Society for Quality Control, Chicago, Ill.

The helium pressurization and Radiflo methods of leak determination are described and compared. Each method employs a tracer gas. He is used as the tracer gas in the helium pressurization method and ^{85}Kr in the Radiflo method. He will enter a part faster than Kr, therefore the Radiflo method is slower. The Radiflo method may be used to measure rates as low as 1×10^{-10} atm cc/sec air, while He will yield acceptance/rejection data to 1×10^{-9} atm cc/sec air. The Radiflo method has a radiation hazard while the He pressurization method's only hazard is the high pressure involved. The Radiflo method is readily adapted to laboratory requirements while He pressurization is suitable as an inspection tool. (F.S.)

19815 (SC-RR-66-423) MAGNETICALLY IMPLODED METAL FOILS. Waag, R. C.; Freeman, J. R.; Cnare, E. C. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1966. Contract AT(29-1)-789. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The radial implosion of a cylindrical metal foil by circumferential currents initiated by a capacitor discharge is described by a set of coupled nonlinear time-varying differential equations based on a lumped parameter model for the electromechanical system. Numerical results showing the magnitude of the variables involved and the electromechanical energy conversion efficiencies are presented. Good agreement between the numerical results obtained and experimental data supports the validity of the model used to describe the processes. (auth)

19816 (Y-1565) AN INSPECTION DATA LOGGING SYSTEM (DLS). Groppe, W. A.; Lee, W. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Apr. 5, 1967. Contract W-7405-eng-26. 58p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Automation techniques have been applied to the collection of position and error data from inspection machines. The system provides a rapid and accurate method of obtaining data from these machines. Data are collected in a form suitable for use with digital computers. (auth)

19817 NEUTRON IRRADIATION DEVICE. Suematsu, Shigeru; Suganomata, Shinji (to Hitachi Ltd.). Japanese Patent 1966-7757. Apr. 19, 1966. Nov. 16, 1964.

A device is described in which a sample material can be irradiated with neutrons, uniformly and effectively. The device consists of the neutron-producing target installed at the end of the accelerating tube; a rotary disc, located behind and in parallel with the plane target; an oblong irradiation room, fixed on and behind the rotary disc, with the axis in parallel with the surface of the disc. By rotating the disc and therefore the irradiation room, the sample material is irradiated. (NSA of Japan)

19818 ECONOMICAL RADIATION PROTECTION IN TELE-GAMMA THERAPY. Koeppe, Peter; Scheffler, Andreas (Freie Univ., Berlin. Staedt. Krankenhaus Westend, Berlin). Strahlentherapie, 131: 552-9(Dec. 1966). (In German).

Economic problems concerning the installation of a telegamma therapy unit are discussed. Radiation protection should be based on a normed irradiation technique. For this reason, the dose distribution in an irradiation room of a ^{60}Co unit was measured several times over a period of one month. Based on these results, wall thicknesses were obtained which are considerably smaller than previously assumed. The use of these results for other room dimensions is discussed. (auth)

19819 DIFFERENTIAL CALORIMETER FOR IN-PILE GAMMA-RAY-HEATING MEASUREMENTS. Herbst, Dale A.; Talboy, James H. (Argonne National Lab., Ill.). Nucl. Appl., 2: 423-8(Oct. 1966).

A differential calorimeter for making in-pile gamma-ray-heating measurements in the range from 3 to 500 mW/g of sample is described. Results obtained with two separate calorimeter systems of the same type are in agreement to within 10%. Some design considerations are discussed, and representative results of measurements made at two reactors are given. (auth)

19820 SNAP 50/SPUR POWER CONVERSION SYSTEM OBJECTIVES, CURRENT STATUS, AND LUNAR APPLICATIONS. Gruntz, R. D.; Rackley, R. A. (Garrett Corp., Los Angeles). pp 210-21; 32 of Aerospace Fluid Power Systems and Equipment Conference. New York, Society of Automotive Engineers, Inc., 1965.

The SNAP-50/SPUR potassium Rankine-cycle power-conversion system technology is described, including the status of development of the potassium boiler, potassium turbogenerator, condenser/radiator, pumps, and control system. Current test results and hardware are shown. A discussion of a potential lunar application and associated problems is included. Conclusions reached are that the high-temperature Rankine cycle with potassium as the working fluid is an excellent choice for applications of this nature because of the light weight, compact size, and simplicity inherent in this system. (auth)

19821 PULSED, HIGH INTENSITY SOURCE OF SOFT X RAYS. Beckner, Everet H. (Sandia Lab., Albuquerque, N. Mex.). Rev. Sci. Instrum., 38: 507-11(Apr. 1967).

A description is given of the techniques and apparatus employed to generate a high density keV plasma capable of serving as an intense source of soft x rays. The spectral distributions of the emission spectra were analyzed and details of the analysis are presented. The distributions are characteristic of 5–10 keV optically thin plasma continua with line radiation superimposed. Source intensities of from 0.1 to 5 MW are readily produced, lasting for a few tenths μsec; these intensities are a strong function of the material used for discharge tube electrodes, varying as Z^4 for $Z \leq 30$. Finally, cursory experiments were conducted to examine the feasibility of filtering these spectra to obtain a monochromatic radiation source. (auth)

19822 RADIATION PROTECTION DRY WINDOWS FOR HOT CELLS. Jahn, Walter (Brunke Garrels Verlags-buchhandlung, Hamburg). Glas-Email-Keramo-Tech., 17: 130-3(Apr. 1966). (In German).

Hot cells, in which fuel elements are examined, or split, or in which radioactive isotopes are chemically converted, are a part of nuclear research centers and isotope laboratories. In order to achieve a sufficient shielding of the high gamma doses (max. 10^4 to 10^5 Curie), considerable wall thicknesses of the hot cells are necessary. Concrete walls 1 meter thick and more are not unusual. The radiation shielding windows built into the hot cells have relatively large viewing openings corresponding to these wall thicknesses. The windows of such dimensions are composed of several thick glass blocks. (tr-auth)

19823 METHODS OF SEPARATING OR CLASSIFYING MATERIALS, REFINING MOLTEN METAL, AND MANUFACTURING INGOTS OR OTHER CASTINGS AND APPARATUS FOR BOILING ELECTRICALLY CONDUCTING LIQUIDS. (to Nihon Genshiryoku Kenkyu-sho). British Patent 1,059,083. Feb. 15, 1967. Priority date Aug. 27, 1963, Japan.

A method is described for separating materials, e.g., separating a dispersed phase from a mixed phase fluid by electromagnetic forces. The continuous phase of electrically conducting liquids and the dispersed phase are acted on by electromagnetic forces corresponding to their electrical conductivities. The dispersed phase obtains a velocity relative to the continuous phase which is different from that obtained when the phases are placed under gravity. The dispersed phase is caused to rise or fall without density control. This method is used for classification of particles, purification of molten metals, casting ingots and other metal masses, and boiling of liquids. The electromagnetic effect can be obtained by a combination of a dc magnetic field (obtained with a permanent magnet or an electromagnet) and a dc current or by a combination of an ac electromagnet and an ac current. (F.S.)

19824 CRITERIA OF SECTION III OF THE ASME BOILER AND PRESSURE VESSEL CODE FOR NUCLEAR VESSELS. New York, American Society of Mechanical Engineers, 1964. 22p.

A new set of design criteria which were used in preparing Section III, Vessels in Nuclear Service, is described. These design criteria shifted the emphasis from the use of standard configurations and toward the detailed analysis of stresses. Section III uses the maximum shear stress theory of failure, instead of the maximum stress theory, because of its ease of use and its advantages in fatigue analyses. The calculation of thermal stresses is required. The stress limits of these design criteria are intended to prevent failure due to a single application of pressure, the combination of primary and secondary stresses, and fatigue. (L.C.L.)

19825 IMPROVEMENTS IN OR RELATING TO PRESTRESSING OF CONCRETE PRESSURE VESSELS. Burrow, Reginald Edwin Downton (to Taylor Woodrow Construction Ltd.). British Patent 1,054,588. Jan. 11, 1967. Filed July 27, 1964.

A prestressed concrete pressure vessel is circumferentially stressed by means of prestressing wires wound around it under tension in a number of layers. The wires are accommodated in circumferential troughs or channels provided in or on the outer surface of the vessel. The pressure vessel is suitable for use in nuclear power stations or for the storage of gas or other media under pressure. (B.L.M.)

19826 AUTOMATIC MACHINE FOR CUTTING CYLINDRICAL WORKPIECES IN ACCORDANCE WITH PREDETERMINED TRACES. Herengel, Jean; Caillet, Roland (to Commissariat a l'Energie Atomique). British Patent 1,055,635. Jan. 18, 1967. Priority date Oct. 9, 1962, France.

A machine is described for cutting cylindrical workpieces, in accordance with predetermined contours, e.g., helical fins on Mg sheaths for reactor fuel elements. The machine includes a cutter head and means for combining the rotation and advance of a workpiece in accordance with the contours to be cut. The machine is made up of a supporting frame, a main table slidable on the frame, a lead screw connected to a transmission and providing the drive for stepwise movements of the main table, a secondary table slidable on the main table, a cam slidable between two abutments of the main table on a shaft connected to the transmission, and a cam for controlling the movements of the secondary table. The work to be machined is mounted between an axially movable back center and a live center, and the supports for the centers are rigidly secured to the main table. The pedestal of a lead block is secured to the main table and cooperates with a follower rigidly secured to the live center of the head stock. At least one set of spindle bearing cutting tools is provided with means for rotating them and moving them axially perpendicularly to the axis of the workpiece. (B.L.M.)

19827 IMPROVEMENTS IN TUBULOUS HEAT EXCHANGERS. (to Babcock and Wilcox Ltd.). British Patent 1,064,720. Apr. 5, 1967. Priority date Dec. 29, 1962, France.

A tubulous heat exchanger is described which is used in transferring heat between a fluid flowing within tubes and a fluid passing over the tube surfaces. The heat exchanger may be arranged to form a vapor generating and superheating unit for gas-cooled nuclear reactors. (F.S.)

19828 IMPROVEMENTS IN HEAT EXCHANGERS ADAPTED FOR VAPOR GENERATION AND SUPERHEATING. (to Babcock and Wilcox Co.). British Patent 1,060,961. Mar. 8, 1967. Priority date Feb. 28, 1963, United States.

A heat exchanger is described which is adapted for steam generation and superheating particularly with liquid metal as the heating fluid. The heat exchanger consists of a vertically elongated pressure vessel with a container inside. Heating fluid inlet and outlet conduits are provided for the container. There are two assemblies of tubes in the container. One assembly of tubes is used for vaporization and one is used for superheating. (F.S.)

19829 IMPROVEMENTS RELATING TO TUBULAR HEAT EXCHANGE ELEMENTS. (to Babcock and Wilcox Ltd.). British Patent 1,064,506. Apr. 5, 1967. Priority date Sept. 17, 1964, France.

An improved finned tubular heat exchanger element is described. These elements may be utilized in the tube bank of a heat exchanger, a tube wall, or for cans of reactor fuel elements. The fins taper from the root to the tip and are fabricated with an undulating surface. The depth of the undulations increases with the distance from the tube. A tube wall will have diametrically opposed fins with adjacent fins of adjacent tubes connected together. (F.S.)

19830 IMPROVEMENTS IN OR RELATING TO EXTRUSION APPARATUS. Green, Derek (to United Kingdom Atomic Energy Authority). British Patent 1,064,241. Apr. 5, 1967. Filed Jan. 14, 1963.

Extrusion equipment is described which has a resiliently yielding nonmetallic die and means for compressing the die longitudinally while restraining the die from expanding radially outwards. The die is usually fabricated of nylon or polytetrafluoroethylene. A nondeformable housing is used to prevent radially outward expansion and axial movement of the die. The apparatus is used in extruding U bars having Zr sheaths. (F.S.)

19831 PROCESS AND APPARATUS FOR DECANNING FUEL ELEMENTS. (to CEA). British Patent 1,064,593. Apr. 5, 1967. Priority date Jan. 20, 1965, France.

A method and equipment for decanning fuel elements by a continuous chemical process are described. Fuel elements are contacted with a stream of acid etching solution and then with a neutral rinse solution. The canned fuel elements are circulated in cocurrent flow with the acid etching solution and the decanned fuel circulates in countercurrent flow to the neutral rinsing system. The apparatus can operates in a continuous manner and produces rapid dissolution of cans while providing a volume of effluents which is lower than that which is produced by systems which entail the use of batch-feed processes. (F.S.)

19832 PYCNOMETER, MARK IV (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1563).
4 drawings.

A vacuum pycnometer is described which was developed to measure bulk volume as a step in obtaining bulk density of porous reactor fuel pellets. The volume that is actually measured is that volume bound by the exposed surface of the sample and the area over cracks and pores less than 14μ wide. Accuracy is ±0.003 cm^3. Volumes of 0.16 cm^3 are measured directly. Measurement time is 40 min/sample. The pycnometer is used in a hot cell equipped with master slave manipulators. (For details see TID-4100 Suppl. 39) (F.S.)

19833 HIGH POWER COLLIMATOR (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE-1562).
12 drawings.

A collimator is described which is used in the Stanford Linear

Accelerator for isolating sections of the cross section of the electron beam. Isolation is necessary to use electrons which are at certain energy levels. The supports for the collimator are also shown. (For details see TID-4100 Suppl. 39) (F.S.)

19834 IMPROVEMENTS IN OR RELATING TO PIPE LOCATING MEANS. Keenan, Frank; Dawson, Dennis James (to United Kingdom Atomic Energy Authority). British Patent 1,061,032. Mar. 8, 1967. Filed Feb. 27, 1963.

A method is described for locating one end of a nuclear reactor pipe at the charge face. The other end of the pipe is connected to the pressure vessel containing the reactor core. A rigidly mounted member on the charge face defines a narrow circular bearing surface surrounding the end of the pipe and limiting the lateral movement of the pipe. The clearance between the bearing surface and the end of the pipe is at least sufficient to ensure that the clearance is not taken up by radial thermal expansion. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 19790, 19829, and 20830.

19835 (ANL-7263) ON THE STEADY-STATE THERMAL STRESSES IN CYLINDRICAL FUEL PINS DUE TO AXIAL VARIATIONS IN THEIR INTERNAL HEAT-GENERATION RATE. Valentin, Richard A. (Argonne National Lab., Ill.). Dec. 1966. Contract W-31-109-eng-38. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The thermal-stress field in a heat-generating circular cylinder, which is free of external tractions and being cooled by a temperature-independent boundary conductance, is studied within the framework of classical elasticity to determine the effects of abrupt axial changes in the heat-generation profile. Heat-generation rates having both axial jumps and axial ramp changes have been considered, and the integral expressions for the stress and displacement fields evaluated for a wide range of Biot numbers. These evaluations provide a detailed qualitative picture of the resulting stress state and, in addition, demonstrate that the stresses are relatively insensitive to the rate of change of the axial heat generation; the results for discontinuous changes differ only slightly from those for ramp changes. Also, with the exception of the shear stress, the magnitudes of the various stresses in the neighborhood of such abrupt axial changes are not significantly larger than those one would compute using a uniform heat-generation rate and neglecting all axial effects. (auth)

19836 (CEA-R-3141) CODE FLID (DEP 051): PROGRAMME NUMERIQUE ANALYSANT EN DEUX DIMENSIONS LE COMPORTEMENT THERMODYNAMIQUE D'UN LIQUIDE BOUILLANT. (Code FLID (DEP 051). Numerical Program for Two-Dimensional Analysis of the Thermodynamic Behaviour of a Boiling Liquid). Fajeau, Maurice; Saunier, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1967. 60p. (In French). Dep. mn.

A two-dimensional code was developed for analysis of the thermal steady-state and transient behavior of a water loop at high or low pressure, and the thermal and hydrodynamic behavior of a light water reactor hot channel. The fuel elements are assumed to be flat plates. The power and pressure drop variations during transient conditions are obtained from the complementary one-dimensional code CACTUS. (tr-auth)

19837 (CONF-660511-, pp 2,4,1-9) DIGITAL COMPUTER TECHNIQUES FOR THE HEAT TRANSFER ANALYSIS OF IRRADIATION ASSEMBLIES. Park, T. A. (Atomics International, Canoga Park, Calif.).

Computer techniques employed in solving in-pile heat transfer analysis of irradiation assemblies are described. These techniques are used in design and analytical studies. Design studies involve configuration establishment, such that a specimen under given heat generation conditions, would operate at a specified temperature. Analytical studies determine in detail the temperature, temperature gradient, and heat fluxes in the assembly. (F.S.)

19838 (CONF-660511-, pp 2.1.1-10) COMPUTER PROGRAM FOR DETERMINING SPECIMEN AND IRRADIATION CAPSULE COMPONENT TEMPERATURE DISTRIBUTION. Reinke, Charles F. (Argonne National Lab., Ill.).

A computer program written in FORTRAN for the analysis of specimen and capsule component temperature distributions under varying conditions of heat generation is described. The program is used to determine temperature distribution in irradiating a specimen in a reactor. The program will solve four basic heat transfer equations. The program contains three subroutines (H, COND, FUK) which can be used in any order or combination necessary to solve the temperature distribution for a specific capsule configuration. (F.S.)

19839 (CONF-660511-, pp 4,1,1-24) TEMPERATURE CONTROL OF ENCAPSULATED IRRADIATION SPECIMENS. Robertson, J. M.; French, G. H.; Jenkins, A. E. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group).

Methods of achieving and controlling the temperature of irradiation specimens during changes in reactor flux patterns and operation power levels are discussed. These methods include the use of loose ceramic powders, sprayed ceramics, wrapped metallic foil, variable width gas gaps, variable position devices, double-walled capsules with circumferential fins, and reflux capsules. The effectiveness of each of these methods of temperature control is discussed. (F.S.)

19840 (CONF-660608-13) ABSORPTION OF THERMAL RADIATION IN THE TRANSPARENT WALL OF A NUCLEAR LIGHT BULB ROCKET ENGINE. McLafferty, George H. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Apr. 1966. 18p. (UAR-E63).

From 2nd AIAA Propulsion Joint Specialist Conference, Colorado Springs.

An analytical study was conducted to determine heat deposition rates in the transparent wall of a nuclear light bulb rocket engine. Such an engine is based on the transfer of energy by thermal radiation from gaseous nuclear fuel through a solid transparent wall to seeded hydrogen propellant. The analysis employs measured spectral absorption coefficients of fused silica, a possible wall material, with and without corrections for reactor-induced opacity in the walls. The calculations are carried out for a radiant energy spectrum approaching the walls equal to the black-body spectrum at the edge-of-fuel temperature and for a black-body spectrum corrected for the effects of an oxygen seed between the gaseous nuclear fuel and the transparent wall. Calculations are also made to determine the temperature differences across the transparent wall necessary to remove the energy deposited in the wall. Results of the calculations indicate that the addition of an oxygen seed to modify the heat flux incident on the transparent wall has a large effect on the heat deposition and required temperature gradients in the wall. (auth)

19841 (N-67-16013) THEORETICAL INVESTIGATION OF RADIANT HEAT TRANSFER IN THE FUEL REGION OF A GASEOUS NUCLEAR ROCKET ENGINE. Kesten, A. S.; Krascella, N. L. (United Aircraft Corp., East Hartford, Conn.). Jan. 1967. Contract NASw-847. 32p. (NASA-CR-695). CFSTI $3.00 cy, $0.65 mn.

A number of different gaseous nuclear rocket engine concepts have been proposed in which energy is transferred from the fuel to the propellant by thermal radiation: for example, the coaxial-flow reactor and the nuclear light bulb reactor. The temperature distribution in the fuel-containment region of such engines is dependent upon the fuel opacity characteristics. These opacity characteristics can be analytically determined using a heavy-atom model which requires, as a prerequisite, a knowledge of the ionization potentials of the nuclear fuel. To date, two independent theoretical estimates of the first four ionization potentials of uranium have been made. The object of the study was to ascertain the effect of fuel opacity characteristics by using the heavy-atom model and the ionization potentials on the temperature distributions in the fuel-containment region of gaseous nuclear rocket engines. (STAR)

19842 (ORNL-TM-1602) TURBULENCE-INDUCED HEAT-TRANSFER FLUCTUATIONS IN PIPE FLOW OF WATER USING HOT-FILM WALL SENSORS. Armistead, R. A. Jr. (Oak Ridge National Lab., Tenn.). Apr. 1967. Contract W-7405-eng-26. 250p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Carnegie Inst. of Tech., Pittsburgh, Pa.

Heat transfer fluctuations for turbulent water flow in pipes were measured using hot-film wall sensors. The characteristics of the wall layer or "laminar sublayer" between the wall and the turbulent fluid were investigated and found to be of an unsteady character which results in fluctuations in the rate at which heat and mass are transferred between the wall and the fluid. These fluctuations may cause fatigue failure and promote surface corrosion in the wall. Specially designed hot-film sensors, mounted flush with the wall of an insulated 2 in. ID chrome-plated brass pipe and energized by a Lintronis constant temperature anemometer circuit, were used in this study. A sublayer flow model based on random eddy penetration was developed and examined. The intensity of the heat transfer fluctuations was found to decrease with increasing Reynolds number, and a significant correlation exists between the wall sensor heat-transfer fluctuations and the velocity fluctuation in the vicinity of the wall. (L.C.L.)

19843 (SAN-677-6) INVESTIGATION OF FUNDAMENTAL MECHANISMS AND PARAMETERS THAT INFLUENCE STEADY STATE AND TRANSIENT PERFORMANCE OF RANKINE CYCLE LIQUID METAL SYSTEMS. Quarterly Report, October 1-Decem-

ber 31, 1966. Poppendiek, H. F.; Feigenbutz, L. V.; Greene, N. D.; Morton, W. A.; Sabin, C. M.; Connelly, D. J. (Geoscience Ltd., Solana Beach, Calif.). Contract AT(04-3)-677. 21p. (GLR-49). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Research activities on liquid metal boiling studies applicable to Rankine Cycle Systems are described. A heat transfer analysis of the vaporization of a droplet on a hot rough surface is presented. Heat is transferred to the liquid drop by conduction through the issuing vapor film under the drop and by conduction through surface asperities that are in contact with the drop. Predicted vaporization lifetimes are compared to results for smooth surfaces (film boiling) and to experimental behavior. Calculations are made of the cubical dimensions of elementary metal impurities which are left as deposits after the complete vaporization of mercury drops containing additives; different impurity concentrations are considered. A brief survey of information on oxidation of typical boiler tube materials is presented and the results evaluated. Droplet vaporization apparatus has been assembled and all components checked. Some difficulties were encountered in making the system vacuum tight but have subsequently been remedied. A freezing apparatus was built to calibrate the thermocouple which will be used to measure heated mercury droplet temperatures. All major and auxiliary components of the forced flow mercury system have been installed in the isolation chamber. Preliminary leak testing of the system has been satisfactorily completed and the first cleaning stage initiated. (auth)

19844 (TID-23790) THE MECHANISM OF NUCLEATE POOL BOILING HEAT TRANSFER TO SODIUM AND THE CRITERION FOR STABLE BOILING. Shai, Isaac (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering). Jan. 1967. Contract AT(30-1)-3357. 159p. (DSR-76303-45). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Liquid metals and other common fluids, such as water, are compared for the various stages of nucleate pool boiling. It is suggested that for liquid metals the stage of building the thermal layer plays the most significant part in heat transfer from the solid. On this basis the transient conduction heat transfer is solved for a periodic process, and the period time is found to be a function of the degree of superheat, the heat flux, and the liquid thermal properties. A simplified model for stability of nucleate pool boiling of liquid metals has been postulated from which the minimum heat flux for stable boiling can be found as a function of liquid-solid properties, liquid pressure, the degree of superheat, and the cavity radius and depth. Tests were conducted with sodium boiling from horizontal surfaces containing artificial cavities at heat fluxes of 20,000 to 300,000 Btu/ft^{2}hr and pressures between 40 to 106 mm Hg. At relatively low heat fluxes, convection currents have significant effects on the period time of bubble formation. An empirical correlation is proposed, which takes into account the convection effects to match the experimental results. Some recorded temperature variations in the solid near surface during stable nucleate boiling are presented. (auth)

Isotope Technology

Refer also to abstracts 19809, 19985, and 20764.

19845 (HW-81332) THE DENSIFICATION AND ENCAPSULATION OF ISOTOPIC FUELS BY HIGH ENERGY PNEUMATIC IMPACTION INTERIM REPORT. Wheelwright, E. J.; Hammond, V. L. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 26, 1964. Contract AT(45-1)-1350. 32p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The potential for simultaneous densification and encapsulation of a wide variety of isotopic heat source materials by high energy pneumatic impaction has been demonstrated with nonradioactive stand-in materials. Fuel-core material densities, uniformly in excess of 95 percent of theoretical and in some instances in excess of published theoretical densities, have been obtained. Prototypical cylindrical capsules up to 4 inches high by 4 inches in diameter and spherical capsules 2.4 inches in diameter have been made. The simultaneous densification and encapsulation by pneumatic impaction of isotopic heat source materials yields a power source with desirable characteristics. Advanced Hanford nondestructive testing technology, originally developed for the routine quality control testing of reactor fuel elements, is being adapted and applied to the routine inspection of isotopic fuel capsules. Wall thickness determined by ultrasonic examination has been shown to agree exactly with measurements made on sectioned containers. Nondestructive testing technology is being expanded to measure microscopic defects in container walls, detect the presence or absence of thermal bonding between the container wall and contents, detect discontinuities in the contents, and measure the as-fabricated yield strength of the container material. Necessary adaptations for making these determinations on full-activity-level isotopic heat sources are under investigation. (F.S.)

19846 (IA-1107) COINCIDENCE OF HORIZONTAL AND VERTICAL FOCUSING PLANES FOR ELECTROMAGNETIC ISOTOPE SEPARATORS OF THE HOMOGENEOUS SECTOR TYPE. Chavet, I. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Dec. 1966. 15p. Dep. mn.

A relation is derived expressing the necessary condition for the coincidence of the horizontal and vertical focusing planes of a homogeneous sector field, for any incident angle ϵ' and any object distance l' for isotope separators of the homogeneous sector type. For the special case of a parallel incident beam ($1/l' = 0$) the condition can be expressed by a simple relation between the angle of emergence ϵ'' and the image distance l''. Corrections for the effect of fringe field are calculated for the case of a parallel incident beam. For shielded magnets with small gaps, these corrections can be neglected. (auth)

19847 (MND-3607-88) RESULTS OF 10 PERCENT NIMBUS FORCE AND STABILITY TEST MACH 8. Adams, R. C. (Martin Co., Baltimore, Md.). Jan. 1967. Contract AT(30-1)-3607. 269p. DTIE.

A hypersonic force and stability test was performed on a 10% scale stainless steel model of the Nimbus B/SNAP 19 Spacecraft. Tests were conducted under the following conditions: M = 7.86, P_0 = 70 psia, T_0 = 1170°R, q = 0.35 psia, and $R_N/ft = 0.4 \times 10^6$. The purpose of this test was to obtain sufficient experimental data for a motion and destruction study of the re-entering spacecraft. Six-component static aerodynamic data were obtained for all possible attitudes of the spacecraft in various stages of disintegration. In addition, bending moments were measured in the shafts supporting the solar paddles. Nine basic configurations were tested; each was tested with and without insulating blankets that covered the front and rear surfaces of the sensory ring. Each configuration was tested over the α range of $-3°$ to 183° and for roll angles, ϕ, of 0°, 45°, 90°, 180° and 225°. The data obtained make it possible to evaluate six-component force and moment coefficients for all configurations of the spacecraft as it varies in position with α and ϕ ranging from 0° to 360°. The shaft bending moment data indicate that the control housing offers little or no interference effect on the paddle loads, but the interference of the sensory ring can reduce the paddle loads by 50%. The pitching moment coefficient data which were obtained indicate that a number of conditions exist where the vehicle will be statically stable in pitch at angles of attack near zero. However, these data alone are not sufficient to reach the conclusion that the spacecraft will re-enter in a fixed attitude. A dynamic analysis of the re-entry phase of flight conducted under the SNAP 19 Safety Program will determine the probability of the vehicle seeking any stable flight motions. The accuracy of the force and stability data presented has been evaluated and was found to be suitable for the flight motion study. Replicate data points were conducted which demonstrated that the precision of the data was well within data accuracy. (auth)

19848 (MND-3607-91) SNAP 19 GENERATOR FORCE AND STABILITY TEST: MACH 8. Stouffer, C. G.; Fluet, C. A. (Martin Co., Baltimore, Md. Nuclear Div.). Feb. 1967. Contract AT(30-1)-3607. 150p. DTIE.

A hypersonic wind tunnel test was conducted on a 30% scale model of the SNAP 19 generator to obtain force and stability data on the generator. These data will be used in computing the trajectory and motions of the generator as it descends through the atmosphere. The test, was conducted under the following conditions: M = 7.86; stagnation pressure (P_0) = 70 psia; stagnation temperature (T_0) = 1170°F; dynamic pressure (q) = 0.35 psia; and a Reynolds number (Re) = 62,600 based on the model reference length of 1.93 inches. Test data were measured by a six-component, water-cooled, strain gage balance which was mounted both within and external to the model, depending on the model orientation required. Force and moment data were measured on two configurations of the generator over an angle of attack range of from 0 to 180 degrees. Configuration 1, the complete 30% model, was tested for roll angles, ϕ, from 0 to 330 degrees. Configuration 2, which had simulated ablated fins, was tested over a roll angle range of from 180 to 270 degrees. The resulting coefficients were referenced to both the pitch and body axes. Repeatability of the plotted coefficients was within the limits of balance accuracy, with the exception of the α range from 66 to 90 degrees, where adapter interference was responsible for irregularities in some of the plotted coefficients. It was concluded that computed modified Newtonian coefficients are suitable for making preliminary design estimates. Large differences in magnitude between the theoretical and measured results, which occurred at some angles of attack, negate the use of the calculated coefficients for detailed design and can be attributed to flow expansion and/or

compression behind the bow shock and shock interference on some fins. Schlieren photographs taken during the test were used to justify these observations. The required force and stability data for the generator were obtained, but further study using a six-degree-of-freedom analog program is required before any definite conclusions concerning the stability of the generator in flight can be reached. (auth)

19849 (MND–3607-94) RESULTS OF 10 PERCENT THERMAL MODEL TEST, NIMBUS B SENSORY RING: SNAP 19 EXPANDED SAFETY PROGRAM. Shih, C.; Rowe, W. H. Jr. (Martin Co., Baltimore, Md.). Jan. 1967. Contract AT(30-1)-3607. 113p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A 10% scale thermal model test was conducted to obtain the temperature distribution in the Nimbus B sensory ring at 32 locations in the basic structure when the model was subjected to a typical Nimbus B re-entry stagnation heating rate. The temperature distribution will be used to verify the results obtained from a mathematical model of the re-entering Nimbus B. The tests were conducted at the NASA-Ames 3.5-foot Hypersonic Wind Tunnel Facility. The nominal test conditions were Mach 10.4, total pressures of 400, 1000 and 1800 psia, total temperature of 2100°R and model angles of attack of +30°, 0°, −30° and −60°. The only model configuration change involved in these tests was the removal of the external Nimbus B antennae. The data obtained from these tests were in the form of temperature-time histories for each of the instrumentation locations throughout the duration of the model in the stream. There were three major parameters that were studied during these tests. They were angle of attack, total pressure and antennae removal effects. Test results indicate that the thermocouples located on the windward surfaces of the three instrumented separators and the A-frame are the most sensitive to changes in angle of attack. However, the temperatures at locations in the structure connecting the windward and leeward surfaces and at locations on the leeward surface are more stable with angle of attack changes. The spacecraft structure appears to average the total aerodynamic heating to its windward surface so that the internal structure and the leeward surface temperatures do not reflect the large temperature variations found on the windward surface. As far as the antennae removal is concerned, those locations on the separators adjacent to or shadowed by the antennae are most sensitive to their presence. The effect of total pressure on the model temperature distribution was studied at angles of attack of 0° and −60°. In general, the temperature measured on the model was highest at $\alpha = 0°$. The temperatures throughout the model increased with increasing total pressure for both angles of attack tested; however, the rate of temperature increase with increasing pressure abated at $\alpha = 0°$ while it remained essentially constant for $\alpha = -60°$. The trends with total pressure of the temperatures measured in the A-frame were consistent with those of the separators. A study of the temperature distribution in the separators revealed that at $\alpha = 0°$ temperatures differed by as much as 1000°R in a given separator, while at $\alpha = -60°$ the maximum temperature difference did not exceed 700°R. The data will be used in the SNAP 19 Safety Study to establish the validity of the digital computer program developed for the thermal analysis of the Nimbus B spacecraft. (auth)

19850 (MND–3607-94(App.)) RESULTS OF 10 PERCENT THERMAL MODEL TEST, NIMBUS B SENSORY RING: SNAP 19 EXPANDED SAFETY PROGRAM. (Martin Co., Baltimore, Md.). Feb. 1967. Contract AT(30-1)-3607. 205p. DTIE.

Results of scaled thermal model tests conducted to obtain the temperature distribution in the Nimbus B sensory ring on re-entry are tabulated. These data will be used to verify the results obtained from a mathematical model of the Nimbus re-entry and for the SNAP-19 Safety Study to verify the computer program developed for the thermal analysis of the Nimbus B spacecraft. (F.S.)

19851 (MND–3607-95) HEAT DISTRIBUTION ON 10 PERCENT SCALE MODEL NIMBUS B SENSORY RING AND SNAP 19 GENERATOR AT MACH 10. Olson, D. N. (Martin Co., Baltimore, Md.). Jan. 1967. Contract AT(30-1)-3607. 375p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A test was performed to obtain aerodynamic heating rate profiles at M = 10, over the surfaces of a 10% scale model of the Nimbus B sensory ring and SNAP 19 generator at angles of attack from −90 to +90 degrees and at angles of roll of 0, 45, 90 and −45 degrees. The model was constructed of thin skin Inconel 600, had four sting mounting locations to minimize sting interference, and was instrumented with 107 thermocouples—87 in the sensory ring, 19 in the generator and 1 in the generator standoff support. The nominal test conditions in the wind tunnel were: $M = 10.4$, $P_0 = 400$ psia, $T_0 = 2100°R$, $R_N = 0.4 \times 10^5$, $R_l = 2.28 \times 10^5$. The data accuracy is approximately ±10%. The data collected were reduced to a non-dimensionalized set of values which consisted of the ratio of the heat transfer rate at the model wall to a reference heat transfer rate at the wind tunnel conditions for each run. From the results of the test, the following conclusions were made: (1) the sensory ring reduced the aerodynamic heating of the generator to as low as $^1/_{10}$ to $^1/_{20}$ the level at angles of attack near ±90 degrees when the model was at angles of attack between −75 and +75 degrees (passing through zero) and at all angles of roll tested; that is, when the generator was in the wake of the sensory ring, (2) the portion of the sensory ring which received the most overall aerodynamic heating, when averaged over the angle of attack range tested, was the A frame and the area which contained the TV camera, the HDRSS electronics and the multiplexers, (3) the sensory ring received the greatest aerodynamic heating at angles of attack near zero degrees, (4) the generator received the highest aerodynamic heating at angles of attack near ±90 degrees, and (5) the overall heating rate to the outside of the separator was approximately twice the heating rate to the inside. However, when the holes of the separator were located so that maximum flow through them occurred, the inside of the separator received considerable aerodynamic heating. (auth)

19852 (NP–16564) PROJET DE L'ETUDE DES PRODUITS DE FISSION A PERIODES COURTES A L'AIDE D'UN SEPARATEUR D'ISOTOPES CONNECTE A UN REACTEUR. (Study of Short-Lived Fission Products by Means of an Isotope Separator Connected to a Reactor). Crancon, J.; Moussa, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). July 1965. 45p. (In French). Dep. mn.

A project for the study of short-lived fission products using an isotope separator connected with a tangential channel of the Melusine reactor is outlined. Among the measurements envisaged for this project are determination of half lives, identification of mass numbers, research and study of previously undetected nuclei, determination of yields independent of fission, determination of branching ratios, and β and γ spectrometry. The principles of the project are given. The problems to be considered in the design of the project are target arrangement, chemical separations, transport of fission products, separation and collection of ions, measurement equipment, estimation of intensities, and contamination problems. The experimental program is outlined with the consideration of the cost and the personnel needs. (J.S.R.)

19853 (NYO–3666-1) COST–BENEFIT STUDY OF SELECTED PRODUCTS IN ATOMIC ENERGY COMMISSION'S LOW-DOSE FOOD IRRADIATION PROGRAM. (Daniel Yankelovich, Inc., New York). Dec. 1966. Contract AT(30-1)-3666. 242p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A cost-benefit study of six selected products in the AEC low-dose food irradiation program was made. The six selected products were finfish (cod, haddock, sole, and flounder); West Coast Dungeness crab; Alaskan king crab; bananas; Hawaiian papayas; and tropical mangoes. Key recommendations were made including the following: to continue the program for selected products, such as finfish and papayas, as commercialization can be achieved; commercialization objectives should be narrowly defined and work on relatively few products should be continued; selected products should be those for which a well defined market exists; funding should be at a lower rate and fewer products included; and a government sponsored information program should be provided. (F.S.)

19854 RADIOISOTOPE ENERGY SOURCES FOR SMALL MANNED ANTARCTIC STATIONS. Rodden, Robert M. (Stanford Research Inst., Menlo Park, Calif.). Nucl. Appl., 3: 226-32 (Apr. 1967).

Interest in the possible use of radioisotopes to fuel kilowatt-level energy sources is gaining momentum, and several conceptual designs for such devices have been presented. Some of the technical and economic aspects of providing radioisotope energy sources for small manned Antarctic stations are explored. (auth)

19855 THE FIRST INDUSTRIAL GAMMA IRRADIATION PLANT ON THE EUROPEAN CONTINENT. Kuenzli, A.; Baur, P. Sulzer Tech. Rev., 48: 84-7(1966).

The first industrial gamma irradiation plant on the European continent is described. Disposable surgical equipment is effectively and economically sterilized by gamma radiation from a ^{60}Co source. Except for filling and emptying the irradiation containers, the process is automatic. Less stringent sterility is required in the work rooms because the radiation dose administered guarantees sterility in the end product even when operating under nonsterile conditions. (L.C.L.)

19856 DESIGN BASIS FOR PINHOLE GAMMA-RAY CAMERAS. Greenfield, M. A. (Univ. of California, Los Angeles); Koontz, R. L. Contract AT(11-1)-GEN-8. Nucl. Appl., 2: 415-22(Oct. 1966).

The results of a study of the design and use of pinhole gamma-ray cameras in examining irradiated fuel rods nondestructively

is presented. A theory is presented for the performance in terms of sensitivity, resolution, field of view, contrast, and magnification. The performance is described in terms of parameters that are analogous to those used in describing ordinary visible-light cameras. Several cameras were built of depleted uranium to achieve a desired level of resolution and sensitivity. All the cameras have been used successfully to examine irradiated fuel pins nondestructively, and are capable of demonstrating damage, swelling, and cracking in fuel rods. Resolution is of the order of 10 to 20 mils depending on the average photon energy of the source being viewed; they have a $3\frac{1}{2}$-in.-dia field of view at a distance of 2 ft from the camera's center. (auth)

19857 HOT PRESS FOR RADIOISOTOPE SOURCE DEVELOPMENT. Quinby, T. C.; McHenry, R. E. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 2: 390-3(Oct. 1966). (ORNL-P-1882).

A miniature vacuum hot press has been developed especially for forming research quantities of radioactive materials in a glove box or manipulator cell. The hot press can be readily disassembled and reassembled in a glove box through the access ports. The hot-press assembly is small due to the use of self-alignment and a water-cooled furnace jacket. This design allows rapid heating and cooling cycles. The hot press operates at up to 1700°C and 4000 psi on samples of up to $\frac{1}{2}$-in. diam. (auth)

19858 LOGARITHMIC INTEGRATOR FOR RADIOISOTOPE GAUGES. Lopuszniak, Andrzej (Instytut Elektrotechniki, Warsaw). Nukleonika, 12: 157-66(1967). (In Polish).

Calculations are presented of approximation of the integrator characteristic, to the logarithmic characteristic, which is done by adding two diode pump characteristics. The application of this integrator to the linearization of the radioisotope gage characteristics in which the relation between the intensity of radiation and the measured value is given by an exponential equation is described. An error in linearity of radioisotope gage with this integrator depends on the range of radiation intensity change and is contained between about ±0.1% to ±0.85%. The mode of designing the integrator and a graph of an error in linearity of the radioisotope gage containing this integrator are discussed. (tr-auth)

19859 SIMPLIFIED METHOD OF ANALYTICAL DETERMINING OF THE BUILD-UP FACTOR FOR GAMMA RADIATION. Czarnecki, Jerzy; Kowalik, Stanislaw (Katedra Obrony Przeciwatomowej, Warsaw). Nukleonika, 12: 143-56(1967). (In Polish).

An effective method for determining the buildup factor for the most commonly found measuring geometries in the use of isotopes for industrial purposes is described. An experimental attempt to determine them is discussed. The discussion is limited to the radiation source typical for the apparatus, i.e., ^{60}Co, to the typical materials of construction for the walls of the iron reservoir used as a radiation absorbent, and to the G-M counter as a detector (the measurements were performed for the counters STS-6 and STS-5). Using the absorption curves obtained by the measurements, a series of generalized formulae was derived defining the absorption coefficient as a function of such parameters as the collimation coefficient of the beam of gamma radiation, distance from the source and distance of the detector from the absorbing layer. (tr-auth)

19860 APPLICATION OF THE LOW ACTIVITY ISOTOPIC SOURCES TO CONTINUOUS CONTROL OF THICKNESS OF THE THIN METALLIC COVERINGS AND DIAMETERS OF WIRES, BY MEANS OF THE X-RAY FLUORESCENCE. Bednarek, Boguslaw; Jelen, Kazimierz; Ostrowski, Kazimierz (Instytut Techniki Jadrowej, Krakow). Nukleonika, 12: 135-41(1967). (In Polish).

Geometric conditions for thickness gages for metallic coverings and wires, such that the signal in same interval of lengths (20 to 40 mm) does not depend on the sample-counter window distance, were established. Two solutions of the problem were pointed out: application of the counter with the screen blinding central part of the window, and using the point source or annular one with the experimentally chosen radius. The advantage of this method is the capability of performing measurements of covering thickness of the metallic plates, and diameters of wires, when the distance sample-counter window alternates. The method requires source of radiation of the relatively low activities (e.g., 100 μCi). (tr-auth)

19861 EXPERIMENTAL STUDY OF AN ION SOURCE FOR ELECTROMAGNETIC ISOTOPE SEPARATION WITH A VIEW TO HIGH EFFICIENCY OPERATION. Chavet, I.; Bernas, R. (CNRS, Orsay, France). Nucl. Instrum. Methods, 51: 77-86(1967).

A conventional ion source with minor modifications was systematically investigated to determine the role of each of its parameters: cathode temperature, arc voltage, magnetic field, gas pressure, etc. The ultimate aim was the attainment of high efficiency operation, preserving an acceptable beam quality (line resolution). A practical method for the optimal adjustment of the various source parameters was developed. When correct operation principles were followed, the source was found capable of stable operation, yielding reproducible results at high efficiencies. Using a cathode of one mm diameter, efficiency values of 30%, 68% and 42% measured at the emission slit were obtained for argon, xenon and mercury, respectively. (auth)

19862 ISOTOPE SERVICES. Westholm, S.; Schmeling, P. (Aktiebolaget Atomenergi, Stockholm). Svensk Kem. Tidskr., 79: No. 2, 142-5(1967). (In Swedish).

General aspects on the production of radioactive substances for research, industrial, and medical use at the Swedish Atomic Energy Company are given. Methods for preparation and activation are reported. (INIS-Sweden)

19863 PROCESS AND DEVICE FOR SEPARATING GASEOUS OR VAPOROUS SUBSTANCES ESPECIALLY ISOTOPES. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,056,782. Jan. 25, 1967. Priority date Mar. 9, 1963, Germany.

A process and apparatus are described for separating gaseous substances, especially isotopes, having different molecular weights and/or molecular diameters by ejecting a flow of the mixture through a nozzle-type orifice onto a dividing plate separating the jet from the orifice into two portions. A lighter gas is added to the jet prior to its forming, and the jet is deflected by mechanical means by less than 360° after leaving the nozzle on the way to the dividing plate. The deflecting means is a concave plate, which connects the plate with means for removing the heavy portion of the gas mixture. A passage is provided for the removal of the light portion of the gas. The nozzle is formed by a part of the deflecting plate and the end of one wall of the passage for the removal of the light portion of the gas mixture. The adjacent end wall of the same passage is formed as a cutting edge that projects into the gas stream emanating from the nozzle and together with the part of the deflecting plate farthest from the nozzle forms the entrance to the passage for the removal of the heavy proportion of the gas mixture. (B.L.M.)

Materials Testing

Refer also to abstracts 19856, 19986, and 20591.

19864 (BNWL-SA-1142) NONDESTRUCTIVE TESTING APPLICATIONS IN THE NUCLEAR INDUSTRY. Spanner, J. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 3, 1967. Contract AT(45-1)-1830. 16p. (CONF-670504-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 21st Annual Technical Conference of The American Society for Quality Control, Chicago, Ill.

Nondestructive testing techniques applicable to the nuclear industry are described. Specific applications are ultrasonic and eddy current systems for testing reactor fuel elements, encapsulated isotopic heat sources, solidified radioactive waste storage tanks, very thin-walled tubes used to sheath ceramic oxide fuels, and large stainless steel tubes already installed in steam generators. Emphasis is placed on the importance to the nuclear industry of having nondestructive testing methods which assure an initially sound product that has been tested for its true working conditions and the quality of the product during use. (L.C.L.)

19865 (CONF-660511-, pp 1.1,1-6) TENSILE COUPON IRRADIATION TECHNIQUE. Coplin, D. H.; Lyons, M. F.; Pashos, T. J.; Weidenbaum, B. (General Electric Co., San Jose, Calif. Nuclear Technology Dept.).

An irradiation technique was developed to obtain high levels of neutron exposure in fuel cladding materials by utilizing space on an existing irradiation experiment. Tensile coupons were attached to the fuel assembly in the space between shroud tubes in the UO_2 High Performance Program, PA17. This irradiation technique provided high-exposure tensile coupons free from chemical, thermal, or mechanical forces. (M.C.G.)

19866 (CONF-660511-, pp 2.3,1-10) ASSESSMENT AND CORRELATION OF ERRORS IN PRE- AND POSTIRRADIATION MEASUREMENTS. Demick, L. E. (Atomics International, Canoga Park, Calif.).

The techniques and procedures for measurement system analysis and for assessment of measurement accuracy requirements in irradiation testing programs are discussed. Methods utilized to set "order of magnitude" accuracy requirements are illustrated. (M.C.G.)

19867 (CONF-660511-, pp 4.9,1-8) SURVEILLANCE OF IN-PILE TESTS USING NEUTRON RADIOGRAPHY. Carbiener, Wayne A. (Battelle Memorial Inst., Columbus, Ohio).

Neutron radiography as a means of nondestructively examining

radioactive materials is described. Neutron radiography consists of activating a metallic foil or screen by a well-collimated neutron beam after it has passed through the object under examination. The "image" of the object is formed on the screen in relation to the neutron absorption characteristics of the object. Fabrication of new devices will permit the examination of irregular geometries and deformed specimens. Devices planned will be able to examine irradiated specimens up to 10 ft in length. (F.S.)

19868 (CONF-660511–, pp 7,4,1-9) INSTRUMENTATION AND DATA REDUCTION TECHNIQUES FOR IRRADIATION EXPERIMENTS. West, D. B. (Atomics International, Canoga Park, Calif.).

Experiments were performed to evaluate fuel element performance over a wide range of compositional variables temperatures, burnups and burnup rates. Instrumentation and data reduction techniques are described for displaying and automatic recording of cladding temperatures, neutron flux, and gas pressure within the fuel element. Temperature control systems are described. Data acquisition is obtained by solid state data loggers and punched paper tape output. (F.S.)

19869 (CONF-660511–, pp 7,6,1-20) NONDESTRUCTIVE TESTING OF THIN SODIUM ANNULI TO DETECT VOIDS. Cihi, John J.; Langham, Milton L. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center).

Eddy current, ultrasonic, and x-ray techniques for nondestructive testing of capsules to be irradiated in the EBR-II were investigated. These methods of inspection were developed to locate voids in the sodium annulus between the fuel rod clad OD and the capsule wall ID. The eddy current testing method showed the most promise and proved to be a successful nondestructive method of inspection. (F.S.)

19870 (ORNL-P-2723) COMPUTER DESIGN OF EDDY-CURRENT TESTS. Dodd III, C. V.; Deeds, W. E. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 15p. (CONF-670505–2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 5th International Conference on Nondestructive Testing, Montreal, Canada.

This technique has been applied to a number of eddy-current problems and can be applied to many others. The restrictions of our present program, axial symmetry and sinusoidal driving currents are not true limits. As computers grow larger and faster, it will be possible to program and solve problems with three-dimensional nonsymmetric lattices. Sinusoidal driving currents are only a convenience, and could be replaced by time-sequential currents, and a time-sequential relaxation performed. A nonlinear medium can also be handled in a time-sequential relaxation if the nonlinearity of the medium is known. This technique gives further insight into eddy-current phenomena, allows the design of actual eddy-current systems, and takes the design of eddy-current coils from an empirical to a scientific basis. (auth)

19871 (ORNL-P-2725) OPTICAL METHODS FOR STUDYING ULTRASONIC PROPAGATION IN TRANSPARENT MEDIA. Whatley, H. L.; Cook, K. V.; McClung, R. W.; Snyders, L. S. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 30p. (CONF-670505–3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 5th International Conference on Nondestructive Testing, Montreal, Canada.

Visual means of observing ultrasonic phenomena show promise of being a valuable tool in nondestructive testing. After studying many different combinations of equipment, a highly sensitive optical system was developed with which can be observed both cw and pulsed ultrasound in transparent solids and liquids by a schlieren technique and in transparent solids by a photoelastic technique. The schlieren technique seems especially promising for visual study of ultrasonic phenomena at water-solid interfaces and inside some transparent solids while the photoelastic method is useful for quantitative study of stress-strain mechanics in transparent solids. There are good reasons for believing that the schlieren method can be applied to flaw detection although work on this problem is still in the early stages. (auth)

19872 (UCRL-14551) EFFECTIVE STRAIN RATES IN LOW-SPEED UNIAXIAL TENSION TESTS. Hamstad, Marvin A.; Gillis, Peter P. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 11, 1965. Contract W-7405-eng-48. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effect of the ratio of specimen stiffness to testing machine stiffness on the effective specimen strain-rate (deformation) is examined analytically for ordinary, low-speed, uniaxial tension tests. The feasibility of constant strain-rate tests, the effective strain-rate during a constant crosshead speed test, and the effects of specimen geometry on the strain-rate are all examined as functions of the stiffness ratio. Finally, the specimen strain-rate is examined for cases when the deformation is localized. (auth)

19873 (UCRL-14570) DETERMINING THE DYNAMIC ELASTIC MODULUS AT ELEVATED TEMPERATURES BY USING RAPID HEATING TECHNIQUES. Austin, A. L.; Parker, R. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 6, 1965. Contract W-7405-eng-48. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method of determining the dynamic elastic modulus at elevated temperatures is reported. It consists of discharging a low-inductance capacitor bank through a preheated thin rod of the test material, which is clamped at one end and free at the other. The transient i^2R heating during bank discharge takes place in a short time interval compared to the mechanical response time of the rod, inducing longitudinal oscillations. The periodic motion of the free end of the rod interrupts a collimated light beam directed over the rod and on to a SD-100 photodiode whose output is recorded on a 561A Tektronix oscilloscope giving a direct measure of the modulus, which is inversely proportional to the square of the period of oscillation. The theory, experimental apparatus, and method are discussed and sample data are given for tests made on 304 stainless steel to illustrate the accuracy and usefulness of this technique. The data are compared with those of other investigators using other methods, and excellent agreement was obtained. This method is particularly useful for testing hazardous materials where remote operation is required for safety. (auth)

19874 PROGRESS IN X-RAY FLASH TECHNIQUES. Rodewald, Hans J. (Omni Ray Ltd., Munich). Microtechnic, 20: 381-3(Aug. 1966). (In German).

Development and applications of flash x-ray equipment (105 to 2000 kV) are reviewed. X-ray flashes of extremely high output and short duration may be produced if advantage is taken of the field emission in a specially designed array of electrodes in conjunction with a modified Marx generator fitted with easily exchangeable elements embedded in synthetic material. The apparatus requires neither costly picture amplifiers, water cooling, vacuum pumps, special electrical connections, nor skilled operators. A performance comparison is given in a table which shows x-ray voltage (kV) output amplitude (kW), flash duration (sec), and irradiation power (mm Al at a distance of 1 m under standard conditions) as well as the focal point dia (mm). X-ray flash techniques are replacing, in certain fields, static x-ray inspection. A new range of application is the testing of "hot," e.g., highly radioactive, fission products as to their quality. In this case normal continuous x-ray exposure fails due to the fact that the film becomes exposed more by radioactive radiation than by the x-ray source itself. The blackening of the film by the radioactive material may be prevented if the x radiation is applied in form of a short impulse of extremely high output, e.g., a flash. The field emission principle permits, besides the construction of small, lightweight, and mobile apparatus, its operation without the aid of screens and/or dark rooms. (BBB)

19875 GAMMA-RAY NONDESTRUCTIVE TESTING OF MATERIALS. Freyer, G. (Otto von Guericke Technische Hochschule, Magdeburg, Ger.). Isotopenpraxis, 3: 1-7(Jan. 1967). (In German).

Various applications of gamma-ray defectoscopes for nondestructive materials testing are reviewed. The gamma-ray testing method is described as to theoretical foundation, application of different sources and source containers to the device, experimental results of materials testing using the device, and an evaluation of the uses of this technique. (L.C.L.)

19876 INSPECTION APPARATUS FOR ARTICLES COMPRISING A COLUMN OF MEMBERS ARRANGED END TO END IN A THIN WALLED SHEATH. Thompson, William; Rogerson, Victor (to United Kingdom Atomic Energy Authority). British Patent 1,062,212. Mar. 15, 1967. Filed Feb. 26, 1963.

An apparatus is described for inspecting reactor fuel elements which consist of a column of right cylindrical pellets of fissile material arranged end to end in a thin sheath. The apparatus is comprised of a 5 Ci ^{147}Pm source which provides low-energy x radiation capable of penetrating the sheath, a means for collimating the radiation from the source into a sheet-like beam, a means for traversing the article to be inspected, and a scintillation counter for detecting and indicating changes in the absorption of the beam as it traverses the article to be inspected. (F.S.)

Protective Structures

Refer also to abstracts 19812 and 21376.

19877 (AD-641199) COOLING WATER FOR FALLOUT SHELTERS. Final Report. Hughes-Caley, F. (Stanford Research Inst., Menlo Park, Calif.). Mar. 1966. Contract OCD-PS-64-201. 68p. CFSTI $3.00 cy, $0.65 mn.

The feasibility of prospecting for, tapping, and recovering ground water, working from within fallout shelter boundaries, for use as a shelter ventilating air coolant was determined. A literature search was made into the background of established techniques of soil penetration and well construction, with particular emphasis on those that might lend themselves to manual operation in the event of a complete absence of power. The background study permitted an assessment of the relative practicability of existing techniques in the light of the limiting circumstances of fallout shelter environment. (TAB)

19878 (ORNL-TM-1750) ATTENUATION OF SHOCKS IN TUBES BY ORIFICE PLATES. Dresner, L.; Chester, C. V. (Oak Ridge National Lab., Tenn.). Feb. 9, 1967. Contract W-7405-eng-26. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A tunnel which is used as a protective shelter during nuclear attack is more effective if some device is employed to hinder the entrance of shock waves from a nuclear explosion, or attenuate the wave if it enters the tunnel. Experiments on the effectiveness of orifice plates in attenuating shock waves in tubes are discussed and a 4 in. explosively driven shock tube is described. (F.S.)

Radioactive Material Handling

Refer also to abstracts 19810 and 19822.

19879 (BNWL-373) SOLIDIFICATION OF HIGH LEVEL WASTES. PART VI. MIXED PHOSPHATE, BORATE, SILICATE MELTS FOR FIXATION OF PUREX TYPE WASTES. Barton, G. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1967. Contract AT(45-1)-1830. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Borates and silicates are compatible with phosphates in glasses over a certain range. Borates reduce the melting temperature and viscosity of both silicate and phosphate glasses or melts. A study is described which was made to determine the effects of substituting various fractions of borate, silicate, and mixtures of them, for phosphate, with a fixed waste composition of the Purex type. Only at the 40 atom per cent waste level was there definite indication of improvement of properties of the phosphate solid by adding borates and silicates. At other levels, there was general deterioration. The The use of a statistically designed pattern of mixtures permitted calculation of contour surface maps of the properties tested. These maps represent trends in the properties but not accurate representations. (F.S.)

19880 (IDO-12046) EQUATIONS FOR THE SORPTION OF CESIUM AND STRONTIUM ON SOIL AND CLINOPTILOLITE. Hawkins, Daniel B. (Idaho Operations Office (AEC), Idaho Falls. Health and Safety Div.); Short, Heber L. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1965. 40p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Four equations were obtained which permit the calculation of the distribution coefficient for the sorption of cesium and strontium on soil and clinoptilolite. These equations hold over the following concentration ranges of the solution phase: calcium 5 to 500 ppM, sodium 6 to 650 ppM, potassium 1 to 100 ppM, ammonium 1 to 100 ppM, magnesium 1 to 125 ppM, cesium 0.05 to 5 ppM, phosphate 0.1 to 10 ppM, and pH 4 to 9. The equation for the sorption of cesium on soil appears applicable to areas other than the NRTS, where illitic soils predominate. The equation for the sorption of strontium on soil may be applicable to soils at other sites in which the sesquioxides are not abundant. The equations obtained herein coupled with a knowledge of the rate of movement of the ground water at the NRTS make it possible to estimate the rate at which cesium-137 and strontium-90 released to the ground from waste-disposal operations will migrate through the soil. (auth)

19881 (NP-16597) THE TREATMENT OF EUROCHEMIC MEDIUM LEVEL WASTE BY THE NEUTRALISATION SELF-SOLIDIFICATION PROCESS. Progress Report No. 1. Hild, W.; Lopez-Menchero, E.; Lazzaretto, J. F. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Sept. 1966. 54p. (ETR-194). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

An assessment is made of Eurochemic's medium-level waste production during the period 1966 to 1970 including: chemical compositions, activities, volumes, and storage situation. The state of the work on medium-level waste treatment in August 1965 is described and a detailed summary of recent experimental work is given, leading to the Neutralization Self-Solidification (NSS) Process. The features of this very flexible process are described and the following tentative functional flowsheets are given: treatment of the decanning waste produced between 1966 and 1970; combined treatment of the decanning waste and "hot waste" concentrates produced between 1966 and 1970; and combined treatment of "hot waste" concentrates and decanning wastes from hypothetical power reactor fuel reprocessing campaigns. According to a first evaluation, NSS treatment costs are $\leq 1.39 \times 10^{-2}$ mill/kWh(e). (auth)

19882 RADIOACTIVE WASTE. Grison, Gaston. Euratom Bull., 6: No. 1, 22-6(Mar. 1967).

The problems of processing, packaging, and disposal of all levels of radioactive waste in the Euratom countries are discussed. Solutions to these problems are described. (L.C.L.)

19883 CONTROL OF AIR POLLUTION. Gilpin, Alan. London, Butterworths, 1963. 514p.

Air pollution from radionuclides is considered along with levels and effects of environmental radioactivity. Data are provided on radioactive decay, measurement of ambient radiation, contribution of nuclear installation (especially power reactors) to contamination of the environment, maximum permissible doses, and legislation to control contamination. The effect of radon contamination due to coal combustion and its uptake by humans in foodstuffs is examined. The possible sources and quantities of radioactive contaminants from nuclear power plant waste gases are detailed. Under present safety regulations, the disposal of radioactive wastes to the atmosphere from nuclear power plants involves only a very slight additional irradiation to the public. (BBB)

19884 COLLECTION OF RADIOACTIVE WASTE IN SLURRIES FROM NUCLEAR AND SPENT FUEL PLANTS IN GLASS BODIES. Simmingskoeld, B. K. W. (to Aktiebolaget Atomenergi). Swedish Patent 204,452. May 17, 1966. Filed Mar. 17, 1962.

A substance solution is absorbed in a porous silicic acid body. Infusoria (kieselguhr) or an equivalent porosity forming silicic acid substance is added to one or more dissolved ingredients, preferably as water solutions. These ingredients are absorbed by the infusoria or its substitute. The compound is then dried and melted to form a solid glass solution after cooling down. The process is developed for waste radioactive materials. (INIS-Sweden)

19885 NEW COMPOSITION OF GLASS. Grover, John Roger; Jones, Alan David (to United Kingdom Atomic Energy Authority). British Patent 1,064,583. Apr. 5, 1967. Filed Aug. 20, 1964.

The composition of a glass is described which is suitable for use as the storage media for waste oxides arising from the treatment of irradiated nuclear fuels to remove U and Pu. The glass is composed of 30 to 40% by weight of waste oxides. The remainder is sodium oxide, phosphorus pentoxide, silica, and alumina. (F.S.)

Vacuum Engineering

19886 H^+ FAST ION INTERACTION WITH METAL SURFACES IN ULTRAHIGH VACUUM. Borovik, E. S.; Katrich, N. P.; Nikolaev, G. T. At. Energ. (USSR), 21: 339-45(Nov. 1966). (In Russian).

Reactions of fast H^+ ions with stainless steel and nickel resulting in a weak chemical bond and with tantalum and titanium resulting in a stable chemical bond were studied. A suspension method in ultrahigh vacuum was used to determine the coefficient α of H^+ ion diffusion into stainless steel at 35 keV and the coefficient η of H^+ ion penetration into stainless steel (where $\alpha = 9 \times 10^{-3}$, $\eta = 0.5$ at the region of high concentration of hydrogen penetration considerably exceeding 10^{19} atom/cm^2). The variable pressure method was used for determining the value η as a function of the density of penetrated hydrogen and the metal temperature. The results obtained established the feasibility of using titanium-type metals for trapping fast hydrogen atoms in magnetic traps. (tr-auth)

19887 MODULATION OF BAYARD-ALPERT GAGES. Redhead, P. A. (National Research Council, Ottawa). J. Vac. Sci. Technol., 4: 57-62(Mar.-Apr. 1967).

Methods of modulating the ion current in Bayard-Alpert gages to allow operation at pressures below the normal x-ray limit and the measurement of pressures of electronically desorbable gases (e.g., O_2, CO, and Cl_2 were studied. The first method proposed had two undesirable features: (a) modulation may cause pressure bursts, and (b) some modulation of the x-ray photocurrent occurs. Various alternate modulation methods were examined to determine which method minimizes the undesirable effects. A modulator external to the grid is only effective with electron currents less than 5 mA and with an open end grid. Two methods using a modulator internal to the grid are shown to be satisfactory; in the first, the ends of the grid are left open and the modulator is switched from grid potential (V_g) to about ($V_g - 20$) V. In the second the ends of the grid are closed and the modulator is switched from ($V_g - 20$) to ($V_g - 60$) V. (auth)

19888 TOTAL AND PARTIAL PRESSURE MEASUREMENTS IN THE RANGE BETWEEN $2 \cdot 10^{-10}$ AND 10^{-12} TORR. Hoch, H. Vakuum-Tech., 16: 8-13(Feb. 1967). (In German).

Ultimate total pressures and ultimate partial pressures were measured on a number of ultrahigh vacuum pumping rigs. Evacuation was effected by both oil diffusion pumps and getter-ion pumps. For measuring the total pressure a number of hot cathode and cold cathode ionization gages were fitted to the uhv-container and used simultaneously; partial pressures were measured by means of an Omegatron gage. In particular the variation of the peaks of the Omegatron spectrum has been studied when one or more of the total pressure measuring gages were switched on and off. By baking of the uhv-portion of the pumping rigs gas desorption can be made as low as 10^{-12} torr l/sec/cm^2 and less; the ultimate total equilibrium pressure can be distinctly correlated to the effective pumping speed which per square meter of baked inner surface area is required in order to obtain a given ultimate pressure. As an example, ultimate pressure analyses are given for two uhv-rigs, followed by discussion. By increasing the size of the inner surface (use of large containers) the origin of various gas components as indicated by partial pressure analyses can be determined. A major portion of the hydrogen found left in the container appears to originate from the container walls. (auth)

19889 PERFORMANCE STUDY OF THE ORBITRON IONIZATION GAGE. Meyer, E. A.; Herb, R. G. (Univ. of Wisconsin, Madison). J. Vac. Sci. Technol., 4: 63-70(Mar.-Apr. 1967).

The design, principles of operation, and performance of the orbitron ionization gage are described. Improvements in the orbitron gage have resulted in a design which is very simple with little structure inside the gage to perturb pressure measurements. Gage sensitivity has been increased by a factor of four, so only a 1-μA electron current is now required to produce the same ion current obtained from an 8-mA emission in the Bayard-Alpert gage. Total power input to the gage is less than 100 mW. The ion current is approximately linear with pressure from 10^{-11} to 10^{-5} torr. The linear region can be extended to 10^{-2} torr by operation in a nonorbiting mode. (auth)

19890 PROMISING TECHNIQUE FOR STAINLESS STEEL ULTRAHIGH VACUUM SYSTEMS. Klemperer, Derek F. (Bristol Univ., Eng.). J. Vac. Sci. Technol., 4: 97(Mar.-Apr. 1967).

Commercially available (Ermeto) pipe fittings and valves for stainless steel ultrahigh vacuum systems were tested, and were found to be leakproof after repeated heating to 560°C. Their use is recommended when inert gas-arc welding is not available. (L.C.L.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 20175, 20259, 21062, 21094, 21449, 21469, 21581, 21686, 21757, 21767, 19769, 19778, 21790, and 21805.

19891 (BMwF-FBK-67-07) DRAHTFUNKENKAMMERDIGITALISIERUNG DURCH MAGNETOSTRIKTIONSSIGNALE. (Digitalization of Wire Spark Chamber by Magnetostrictive Signals). Schmidt, K. H. (Technische Hochschule, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik, Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Jan. 1967. 50p. (In German). Dep. mn.

A readout-system of a wire spark chamber with a usable area of 25×25 cm^2 was developed. The coordinates of the sparks were measured by magnetostrictive wires, used as acoustic delay-lines. Tests of the magnetostrictive properties of various types of wires and measurements of resolution and efficiency of a magnetostrictive spark chamber readout-system were performed. For the first time there was used a wire chamber consisting of two wire-planes crossed at 90°. So both coordinates of a spark were determined by one chamber simultaneously. (auth)

19892 (BNWL-337) IN-CELL RECORDING OPTICAL SPECTROMETER. Upson, U. L.; Wheelwright, E. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1967. Contract AT(45-1)-1830. 21p. (CONF-660933-5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 10th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

The application of spectrophotometry to studies involving kilogram-scale separation of ^{147}Pm from process wastes is discussed. (B.G.D.)

19893 (BNWL-339) DOSIMETRY TECHNOLOGY STUDIES, 1965. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1966. Contract AT(45-1)-1830. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Various aspects of the research program at Battelle-Northwest during 1965 on radiation dosimetry are discussed. Topics include thermoluminescent dosimeters and readers, solid-state particle detectors and dosimeters, activation-type personnel neutron dosimeters, portable film densitometers, gamma radiation exposure rate measurements, small chamber exposure rate instruments, criticality incident alarms, plutonium dosimetry studies, and monitoring the dose rate to the gastrointestinal tract. (B.G.D.)

19894 (BRL-MR-1808) TEMPERATURE STABILITY OF A STILBENE SPECTROMETER. Dante, James G. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Nov. 1966. 31p.

A stilbene spectrometer will be used to measure neutron and gamma ray spectral distribution and intensity during Project HENRE at the Nevada Test Site. Daily temperature changes of from 30 to 40°F are expected. The results of an investigation of changes in the entire spectrometer system due to variations in temperature are discussed. Changes in time of output pulses and gain of the entire system were observed over a temperature range of 12 to 132°F. (auth)

19895 (CEA-R-3144) CHAMBRE A HYDROGENE A HAUT TAUX DE REPETITION: ETUDES PRELIMINAIRES. (High-Repetition-Rate Hydrogen Chamber: Preliminary Studies). (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires. Paris Univ. (France). Laboratoire de Physique). Jan. 1967. 106p. (In French). Dep. mn.

Experimental results are presented from tests with a bubbles chamber for studying the possibilities of increasing the repetition rate. The more important parameters (the evolution of the bubbles, the expansion system) are considered in a theoretical way. Then the hardware is described. To end, experimental results are compared with the first evaluations. The calculations and the experimentation are against an oscillation system for the expansion. A system with a locking system is to be considered. (auth)

19896 (JINR-P10-3172) NEKOTORYE VOPROSY PROGRAMMNOGO UPRAVLENIYA SVYAZ'YU EVM "MINSK-2" GRUPPOI POLUAVTOMATOV DLYA OBMERA FOTOSKIMKOV S TREKOVYKH KAMER. (Some Problems of Program Control of Communication Between "Minsk-2" Computer and a Group of Digitized Projectors for Track Chamber Pictures Measurement). Shigaev, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 12p. (In Russian). Dep. mn.

Some problems of program control of two-directional communication in a semi-automatic system for track chamber pictures measurement are considered. The components of the system are as follows: Minsk-2 computer, a group of digitized projectors PUOS and a group of electric controlled typewriters EUM-46. (auth)

19897 (LA-3654) DETECTION OF PLUTONIUM PENETRATIONS THROUGH CONTAINERS AT HIGH TEMPERATURE. Holm, Dale M.; Moore, Bill M. (Los Alamos Scientific Lab., N. Mex.). Dec. 1966. Contract W-7405-eng-36. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A detection system was built for monitoring plutonium penetration through tantalum capsules by counting alpha particles with silicon surface barrier detectors. Small amounts of plutonium (0.1 μg) can be detected on the surface of the test capsule while it is at 1160°C in a high vacuum. The detectors are kept cool by placing them in water-cooled head assemblies and shielding them from thermal radiation by six thin nickel foils. Alpha particles from plutonium lose about 1.5 MeV of their energy in traversing the foils. A total running time of 18,548 hr was logged on two systems, during which 116 capsules were tested. No operator was required in attendance because the experiment was automatically shut down when the leak reached a predetermined value. (auth)

19898 (N-67-16546) DIGITIZED SPARK CHAMBER FOR SPACE SCIENCE EXPERIMENTS. Ross, R. W.; Ehrmann, C. H.; Fichtel, C. E.; Kniffen, D. A. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1966. 16p. (NASA-TM-X-55643; X-611-66-536). CFSTI $3.00 cy, $0.65 mn.

A digitized spark chamber was developed for gamma-ray and charged particle experiments on balloons and satellites. The spark chamber is assembled from modular units, which are stacked to the desired number of levels. Each module consists of parallel spark planes formed from two orthogonal wire grids. Memory cores, strung on the wires of both grids, record the x-y coordinate of the spark. Factors affecting the operating characteristics of these modules are discussed. A gamma-ray detector of 32 module levels has been assembled and balloon-flown in a search for cosmic gamma ray point sources. The construction of this detector is described and its performance briefly discussed. (auth)

19899 (NP-16604) REALISATION DE CAPSULES EN GADOLINIUM POUR DETECTEURS-DOSIMETRES. (Development of Gadolinium Capsules for Detectors and Dosimeters. Technical Note AME 65-17). Daniault, J.; Gillet, R.; Labonne, C.; Oddes, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 31, 1965. 6p. (In French).

The development of Cu or Ti detectors encapsuled between two Gd tablets of 0.3 mm thickness was reported. The principle physical and mechanical properties of Gd and its resistance to oxidation and corrosion are outlined. The forming of the Gd tablets is outlined. The ultrasonic welding technique used is given. Preliminary tests at 650°C and at the temperature of liquid H_2 have shown that the technique used is adequate to insure leak proof detectors. (J.S.R.)

19900 (NP-16620) EMPLOI DU TITANE COMME DETECTEUR DE FLUX RAPIDE INTEGRE. (Use of Titanium as a Detector of Fast Integrated Flux). Lloret, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan. 18, 1967. 29p. (In French). Dep. mn.

The suitability of Ti as a routine detector of fast integrated neutron flux was investigated. After a brief review of known data on the reaction ^{46}Ti(n,p)^{46}Sc, the irradiation conditions and the conditions for detector counting are examined. The lack of knowledge of the reaction cross section caused a calibration by Ni, which was translated into cross sections above 1 MeV for the different experimental placements around the SILOE core. The results showed that in spite of some precautions necessary for a Ti counter because of impurities, this detector is well adapted to irradiation of short and average duration in SILOE. An appendix outlines the angular correlation in the coincidence counting of ^{46}Sc. (tr-auth).

19901 (ORNL-4099) FORTRAN PROGRAM FOR CALCULATING THE SOLID ANGLE SUBTENDED BY ONE CIRCULAR DISC AT ANOTHER. Williams, I. R.; Craig, A. M. Jr.; Thompson, C. L. (Oak Ridge National Lab., Tenn.). Apr. 1967. Contract W-7405-eng-26. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A Fortran II program is described to perform numerical integrations by the Monte Carlo method to calculate the solid angle presented by a circular aperture facing another at any obliquity. (auth)

19902 (ORNL-TM-1764) LINEAR-LOG RADIATION MONITOR, ORNL MODEL Q-2353. De Lorenzo, J. T. (Oak Ridge National Lab., Tenn.). Feb. 22, 1967. Contract W-7405-eng-26. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The linear-log radiation monitor will monitor gamma dose rates over five decades. It provides two separate output signals: a linear signal and a linear-log combination signal. The linear signal actuates a transistorized, high and low off-normal alarm circuit. The linear-log signal is intended to provide a record of abnormal excursions above the linear range. The instrument contains two G-M tubes and a cold-cathode trigger tube in its probe. Both linear and log output signals from the probe are dc currents. Two probe designs are available: for one the linear range is 0 to 10 mr/hr and the linear-log range covers five decades to 10^5 mr/hr; for the other the linear range is 0 to 100 mr/hr and the linear-log range covers five decades to 10^6 mr/hr. The high and low off-normal alarm circuit is fail-safe for the most vulnerable circuit components. Gamma dose rates exceeding 10^6 r/hr will not cause any turn-down of the linear signal and only a very slight turn-down of the log signal. (auth)

19903 (SLAC-PUB-251) HUMMINGBIRD: AUTOMATIC FILM DIGITIZERS AT THE STANFORD LINEAR ACCELERATOR CENTER. van der Lans, J. (Stanford Linear Accelerator Center, Calif.). Jan. 1967. Contract AT(04-3)-400. 24p. (CONF-670105-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Flying Spot Devices, Munich, Germany.

Hummingbird, an automatic spark chamber film digitizer which is connected on-line to an IBM 360/50 computer, is described. The operation of the system is also included. (B.G.D.)

19904 (UCRL-17317) TECHNIQUE FOR DRIFTING LITHIUM INTO GERMANIUM. Jenkins, David A. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1967. Contract W-7405-eng-48. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method that was used successfully to drift Li into Ge is described. A large variation in the performance of samples taken from different ingots was found. For a given ingot the same results were obtained with different samples, so fluctuations in performance were attributed to the original ingot and not to variations in the techniques of fabrication. The lithium drift mechanism is also very sensitive to the presence of impurities. (P.C.H.)

19905 (UJV-1562) POLARIZED NEUTRON CRYSTAL SPECTROMETER. Michalec, R.; Vavrin, J.; Chalupa, B.; Vavra, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1967. 20p. Dep. mn.

Equipment enabling the polarization of thermal and resonance neutrons is described. It consists of a polarizer, a magnetic guide field channel, an analyzer, and an electronic control device. The results of the determination of the instrumental luminosity, the energy resolution of the spectrometer, the polarization of the neutron beam and the efficiency of the polarization reversal are given. (auth)

19906 (UVJ-1729) SIMPLE DIGITAL STABILISATION OF THE γ-RAY SPECTROMETER. Kosina, Z. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1967. 9p. Dep. mn.

A simple instrument was built for use in semiconductor detector spectroscopy to stabilize the gain of a conventional amplification chain and a pulse-height to digital converter in the course of long termed measurements. The stabilization process is based on the auxiliary standard-pulses the voltage of which is considered to be sufficiently stable. The corresponding auxiliary peak whose position can be chosen arbitrarily in the whole range of 1024 channels may, or may not be stored in the memory of the pulse height analyzer. The instrument developed reduces the overall gain fluctuations by a factor of about 40 thereby ensuring the stability required by high resolution spectroscopy. (auth)

19907 (USNRDL-TR-67-14) THE NRDL GAMMA-/X-RAY SCATTERING FACILITY. Gurney, W. J. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 22, 1966. 48p. CFSTI $3.00 cy, $0.65 mn.

A dual detector facility for measuring scattered gamma or x-radiation is described. This facility which uses highly shielded and collimated detectors [NaI(Tl) and Ge(Li)], and a multichannel pulse height analyzer is capable of measuring the spectra of scattered radiation at angles from 1.3 to 135°. Spectral measurements of scattered ^{137}Cs gamma rays (661.6 keV) are currently being made; however, scattering measurements with primary photon energies ranging from 40 to 200 keV are planned. Energy resolutions (^{137}Cs gamma rays) of the 4" × 4" NaI(Tl) detector and the 8 mm (w) × 18 mm (l) × 6 mm depletion depth Ge(Li) detector are 8.16% and ~2.86 keV respectively. Cross sections for differential coherent and incoherent scattering, as well as the photoelectric and the total mass absorption coefficients can be measured using this apparatus. (auth)

19908 (BNL-tr-53) ILLUMINATION OF THE BUBBLE CHAMBER WITH THE AID OF AN OPTICAL RUBY GENERATOR (LASER). Gorbunkov, V. M.; Korobkin, V. V.; Leontovich, A. M. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Dokl. Akad. Nauk SSSR, 164: 75-7(1965). 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

The use of ruby laser (λ = 6943Å) in conjunction with a concentric cavity, which insured a uniform angular distribution of radiation, for uniform illumination of bubble chambers is discussed. (B.G.D.)

19909 FOCUSING CONDITIONS FOR A TRIPLE-AXIS NEUTRON SPECTROMETER. Peckham, G. E. (Univ. of Reading, Eng.); Saunderson, D. H.; Sharp, R. I. Brit. J. Appl. Phys., 18: 473-84(Apr. 1967).

Two methods are described for determining the magnitude of the focusing effects that are observed in phonon measurements using the triple-axis crystal spectrometer technique. Both methods, one purely graphical and the other numerical, can be used to predict the spectrometer conditions that will give optimum focusing for a given phonon. They are illustrated by their application to measurements of a phonon in magnesium oxide, and their relative merits are discussed. These measurements show a variation by a factor of 12.5 in the observed peak intensities due solely to focusing effects (numerically calculated value 13.0), thus emphasizing the practical importance of being able to predict the focusing conditions. (auth)

19910 A HIGH-RESOLUTION, SMALL DIAMETER IMAGE INTENSIFIER GAMMA CAMERA SYSTEM. Wilks, R. J.; Mallard, J. R. (Univ. of Aberdeen, Scotland). Phys. Med. Biol., 12: 251-5(Apr. 1967).

A stationary gamma ray detector incorporating a light image intensifier is described. The light emitted from a 2 in. diameter, 3 mm thick, flat crystal is focused, by means of a special Perspex lens system, onto the photocathode of the image intensifier (also 2 in. diameter) with a 5% efficiency. Using a parallel-hole lead collimator 2 in. long and having 2 mm square holes and 0.007 in. thick septa, it was found that, when using a ^{99m}Tc source (140 Kev), a resolution of 1 mm was obtainable, although contrast was poorer at this value, due in part to the acceptance of unwanted Compton events within the subject, collimator and crystal. Contrast at separations of the order of 2 mm and above was quite good, however. A comparison with other image amplifier systems and with the Anger camera, is made, and future plans are discussed. (auth)

19911 A SIMPLE MOESSBAUER SPECTROMETER. Woodhams, F. W. D. (Univ. of East Anglia, Norwich, Eng.). J. Sci. Instrum., 44: 285-6(Apr. 1967).

A simple and inexpensive electromechanical Moessbauer spectrometer, using components easily available, is described. For use with a multichannel analyser a velocity varying triangularly with time is produced, the linearity being to better than 2%. Modifications for converting the system to a constant velocity device for use in the absence of a multichannel analyser are discussed. (auth)

19912 BUBBLE DENSITY AND OPERATING REGION OF A PRESSURE STABILIZED PROPANE BUBBLE CHAMBER. Kunkel, P.; Christenn, G.; Scheer, M. (Univ., Wuerzburg, Ger.). Z. Angew. Phys., 22: 407-12(1967). (In German).

Using a temperature- and pressure-stabilized bubble chamber the sensitive region for propane as a chamber liquid was studied. As a function of the three operating parameters temperature, pressure drop, and time of growth of the bubbles the bubble density of particles of minimum ionization is determined. Bubble densities up to 120 bubbles/cm were achieved. (auth)

19913 POSSIBILITY OF MEASUREMENT OF OPTICAL CHARACTERISTICS OF PACKED SCINTILLATORS. Mokhir, E. P.; Tsirlin, Yu. A. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 6: 244-8(Feb. 1967). (In Russian).

The scintillation light self-absorption coefficient in NaI(Tl) crystal packed in a standard container was determined by measurement of the crystal light output. The scintillator output window was screened by various diaphragms. Comparison of the data obtained by the proposed methods with the results of the optical measurements of the absorption coefficient confirms the validity of the methods used. (auth)

19914 CONTRIBUTION TO THE STUDY OF A DECONVOLUTER-CONVOLUTER FOR ANALYSIS OF COMPLEX SPECTRA. Sau, Jacques; Morgue, Michel; Chery, Roland (Univ., Lyon). Compt. Rend., Ser. B, 264: 187-90(Jan. 9, 1967). (In French).

Two ensembles for the analysis of complex spectra are proposed. Their operation is based on the Seidel procedure. In order to avoid the limitations of this procedure, the assemblies permit preliminary convolutions by judiciously chosen pulse responses. (tr-auth).

19915 METHOD OF DETERMINATION OF INTENSITY OF THE MONOENERGETIC GAMMA RADIATION IN COMPLICATED SPECTRA WITH A SCINTILLATION GAMMA SPECTROMETER AND ABSORPTION FILTER. Makariunas, K.; Makariuniene, E. (Dept. of Nuclear Physics and Application of Radioactive Isotopes, Vilnyus, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 6: 111-17(1966). (In Russian).

The method of investigation of the gamma spectra with a scintillation gamma spectrometer and absorption filter is described. In some cases the method is much simpler and therefore facilitates the determination of the intensity of gamma lines of the spectrum. The essence of the method is in the measurement of gamma radiation which is absorbed in a filter. The photopeaks in the scintillation spectrum of this radiation are resolved better, and the continuous background due the Compton absorption of the harder radiation is very low. This permits the use of curves of Gauss distribution to exclude the photopeaks from the amplitude spectrum and to determine its intensity. The method is verified with the gamma spectrum of a mixture of radioactive tellurium isotopes. (auth)

19916 SCANNING AND MEASURING DEVICE FOR THE EVALUATION OF PHOTOGRAPHS. Likhtenbaum, L. L.; Lyulevich, V. I.; Fedotov, O. P.; Gordeeva, T. F. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 349-58(1966). (In Russian).

The track chamber picture scanning and measuring device is described. A mechanical system is used to measure the distance between a centering mark and a point of the track element. The measurements are made by means of an electronic system; the data obtained are fed to a card punch or magnetic tape recorder. (auth)

19917 COUPLING ON LINE AND LOGIC FOR THE EXCHANGE OF INFORMATION BETWEEN THE MEASURING PROJECTOR FOR THE TREATMENT OF THE TRACK CHAMBER PHOTOGRAPHS AND THE COMPUTER. Kishinevskaya, L. P.; Melik-Martirosyan, G. A.; Nanasyan, A. S.; Oganesyan, D. G.; Teplyashina, L. V.; Kheifets, S. A.; Cheishvili, K. G. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 365-71(1966). (In Russian).

An investigation is made of the logical coupling on line for the measuring projector in the treatment of track chamber photographs and computer allowing the filtration and control of the information entering into the computer during the operation process. The functional schemes of the logical work and the set-up on line of the projector and the computer coupling are dealt with. (auth)

19918 SCANNING AND MEASURING PROJECTOR (S.M.P.) FOR BUBBLE CHAMBER TRACK MEASUREMENT. Kalinin, V. M.; Mamaev, V. L.; Mikheev, V. P.; Rozov, B. S.; Cheremisinov, G. V. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 372-9(1966). (In Russian).

Design features and accuracy of particular elements are considered and experimental results on the determination of the accuracy of measurements are presented. Two possible blockschemes of Measuring Center Design based on SMP with magnetic tape recordings are described. (auth)

19919 TRACK DENSITY MEASURING WITH THE HELP OF SCANNING AND MEASURING PROJECTOR. Mamaev, V. L.; Mikheev, V. P.; Rozov, B. S.; Cheremisinov, G. V. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 380-5(1966). (In Russian).

Measurements of the track density with the help of scanning and measuring projector, using the films from a bubble chamber are described. The measuring instruments are described and the results of the experiments are discussed. (auth)

19920 SCANNING MEASURING TABLE. Likhtenbaum, L. L.; Lyulevich, V. I.; Mileshin, V. A.; Fedotov, O. P. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 386-96(1966). (In Russian).

A technical description of a scanning-measuring table, designed and built for evaluation of the bubble chamber and spark chamber photographs. The measurements are made on a 10 time enlarged film image. The least count of the counting system equals 50 mcs. A perforator is used to record the output data. A keyboard device is used to record all the auxiliary information. (auth)

19921 USE OF SLOW-SCAN TELEVISION SYSTEM IN READING OUT SPARK CHAMBER DATA. Kantserov, V. A.; Kotel'nikov, V. P.; Kulyabichev, Yu. P.; Rozov, B. S. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 397-405(1966). (In Russian).

The possibility of designing a TV system for automatic recording of spark-chamber track coordinates is considered. The advantage of slow-scan TV systems for low rate events registration is shown. The results of researching the possibility of using Vidicon with a spark chamber in a slow scan regime are set forth. The research was conducted on a laboratory model. The horizontal and vertical sweep rates were 50 and 1 c/s respectively. The ray-current of Vidicon was cut off for 1 to 2 sec during the start of the spark chamber to protect the TV camera from strays. The signal is read out by memory. The photographs of video-signals of spark discharge in the air and neon are reproduced. The energy of the spark was 0.08 joules. (auth)

19922 AUTOMATIC SYSTEM FOR HANDLING AN INFORMATION FROM WIRE SPARK CHAMBERS. Belyakov, E. S.; Buyukyan, S. P.; Davidyan, D. B. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 406-9(1966). (In Russian).

An automatic system for handling information from wire spark chambers, for operation on-line, and designed for registration of only single particles, is described. This system within 20 msec can receive and transmit to the computer information from more than 400 chambers with 512 wires each. (auth)

19923 MAGNETIC SPECTROMETER OF WIRE SPARK CHAMBERS WITH AUTOMATIC CALCULATION OF THE MAGNETIC DEFLECTIONS. Asatiani, T. L.; Kovalenko, V. I.; Prokhorov, A. N.; Prokhorov, V. N.; Sagatelyan, P. A. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 410-12(1966).

A description of the block-scheme of a special computing machine for the determination of the deflection of a charge particle in a magnetic spectrometer consisting of wire spark chambers with an area of ~1000 × 1000 mm^2 and withdrawal of information with ferrite cores is described. The electronic part of the computing machine consists of standard cells used in serial electron computers of semiconductor devices. (auth)

19924 DEVICE FOR MEASURING PHOTOGRAPHS BY MEANS OF GLASS FIBERS. Dobyrn, V. V.; Stabnikov, M. V. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 414-17(1966). (In Russian).

A method for measuring the particle phototrack projections on a mat screen is described. Linear binary Grey's code scales and a special assembly (mark) of fiber lightguides are used for reading the information. Some parts of the device are described. An appraisal is made of the potentialities of the device. (auth)

19925 PROJECTOR FOR PHOTOGRAPH SURVEY AND MEASUREMENTS. Buyukyan, S. P.; Vartanyan, S. V.; Vasinyuk, I. E.; Melik-Martirosyan, G. A.; Mkrichyan, K. G.; Nanasyan, A. S.; Kharitonov, V. M. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 359-64(1966). (In Russian).

A functional scheme of a projector operating on-line for survey and measurements of the track chamber pictures is described. The computer stores information, makes preliminary calculations and controls the projector work in the course of measurements. The projector works according to the manual accompaniment of the needed track projection in the given zone with a following automatic precise points coordinates determination of the track. The maximum accompaniment speed along the track equals 10 mm/sec. The width of the scanning zone equals 1 mm on a film (or 12 mm on a projector screen). One bit equals 2.5. (auth)

19926 DEAD TIME ANALYSIS OF THE COUNTING DATA FROM A DECAYING SOURCE. Chezem, Curtis G.; Balagna, John P.; Moore, Roger H.; Ford, George P. (Los Alamos Scientific Lab., N. Mex.). Nucl. Appl., 3: 58-9(Jan. 1967). (LA-DC-7856).

A computer dead-time calculation program using paralyzable and nonparalyzable models in linear combination is described, as well as its use for detection of electronic difficulties in the instrumentation. (auth)

19927 COUNTER TELESCOPE FOR THE MEASUREMENT OF THE POLARIZATION OF FAST NEUTRONS. Bruening, R.; Buesser, F. W.; Christiansen, J.; Niebergall, F.; Soehngen, G. (Institut fuer Experimentalphysik, Hamburg). pp 146-8 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A counter telescope consisting of three parallel-plate avalanche counters was designed for the measurement of the energy and the scattering angle of the recoil α particles from n–^{4}He scattering, which is used as the analyzing reaction for neutron polarization. A diagram is given of the telescope, and results of investigations of some (d,n) reactions using a 3-MeV Van de Graaff accelerator are presented. (L.B.S.)

19928 APPARATUS FOR PROTON POLARIZATION MEASUREMENTS. Blue, R. A.; Stout, K. J. (Ohio State Univ., Columbus). pp 149-51 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Apparatus for the measurement of proton polarization by double scattering was designed and constructed for use in conjunction with the Ohio State 5.5-MeV Van de Graaff accelerator. The apparatus is illustrated and its features are discussed. Initial measurements indicate the feasibility of studying the $^{9}Be(d,p)^{10}Be$ reaction over the entire available energy range up to 5.5 MeV. (L.B.S.)

19929 LIQUID-HELIUM SCINTILLATOR AS NEUTRON POLARIZATION ANALYZER WITH IMPROVED CHARACTERISTICS. Piffaretti, J.; Rossel, J.; Weber, J. (Univ., Neuchatel, Switzerland). pp 152-4 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Some details are given of the construction of a liquid-helium scintillator-polarimeter for measuring, by time-of-flight method, the polarization at neutrons of energy as low as 2 MeV, the helium scintillation being used as the start signal for a time-to-pulse height converter. Some results are presented for a typical α recoil spectra from $N-^{4}He$ elastic scattering. (L.B.S.)

19930 STATISTICAL ERRORS AND TIME BEHAVIOR IN MEASUREMENTS OF COUNTING RATE AND IONIZATION CURRENT. Doerfel, G. (VEB Vakutronik, Dresden). Isotopenpraxis, 3: 8-11(Jan. 1967). (In German).

After briefly discussing the adequate methods of calculation the relation between the time behavior of the smoothing networks and the mean quadratic errors are summarized for the most important types of networks. The formulas given are prepared for the cases of application as counting rate or ionization current measurement and release of a threshold transducer (radioactive relay). Some examples of practical uses are given. Finally, some remarks are made on the measurement of properties of the smoothing networks which cannot be expressed in an analytical form. (auth)

19931 SOME INVESTIGATIONS OF COUNTERS WITH CADMIUM SULFIDE CRYSTALS IN VIEW OF THEIR UTILIZATION AS PROPORTIONAL DETECTORS. Marinov, M.; Marinova, E. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 57-63(1966). (In Russian).

CdS is indicated as a material for nuclear radiation detectors principally with respect to γ quanta because it contains atoms with high atomic number. But the detectors with CdS have a very poor energy resolution capacity with respect to the energy of the ionizing particle. In order to clarify the cause of this phenomenon, the forms of their pulses were studied. The results of experimental studies on a large number of models seeking to clarify certain still unclear uncertainties of the theory were analyzed. The resolution capacities of models of two types (with electrons of a single side and with electrons of two sides) were studied especially. The results lead to the following conclusion. A theoretical examination of the formation mechanism of the pulses must take into consideration recombination processes of the current carriers. In the presence of a very strong ionization density these processes are very probable. Counters with CdS crystals in the present stage of development of the fabrication technology are unsuitable to be used for spectrometric purposes. Among the counters available, those of the dielectric type are most convenient. (tr-auth)

19932 CALCULATED GAMMA EFFICIENCIES OF NaI(Tl) DETECTORS FOR GASEOUS CYLINDRICAL SOURCES. French, R. L. D.; Telfer, N. (United Kingdom Atomic Energy Authority, Seascale, Eng.). Nucl. Instrum. Methods, 51: 159-64(1967).

The gamma detection efficiencies of two sizes of cylindrical NaI(Tl) detectors (2.54 cm × 3.81 cm dia. and 7.62 cm × 7.62 cm dia.) are tabulated for various sizes of gaseous cylindrical sources. It is assumed that the respective source and detector lie on a common axis and that they both have the same diameter. Source heights in the range 1.0 to 10 cm and source-to-detector separations in the range 0.0 to 1.5 cm are considered. These efficiencies were derived by integrating the appropriate efficiencies published for disc sources. (auth)

19933 MARX GENERATOR FOR WIDE GAP SPARK CHAMBERS. Grossman, D. D. (Harvard Univ., Cambridge, Mass.). Contract AT(30-1)-2752. Nucl. Instrum. Methods, 51: 165-8 (1967). (HUX-2752-17).

Details of the construction and performance of a 375 kV Marx generator are presented. (auth)

19934 A HIGH-RESOLUTION, CHARGED-PARTICLE SPECTROMETER WITH DOPPLER CORRECTION. Smith, D. L.; Enge, H. A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Instrum. Methods, 51: 169-71(1967). (MIT-2098-294).

A magnetic spectrometer for high-resolution analysis of charged nuclear reaction products is described. This instrument consists of a broad-range spectrograph with its median plane perpendicular to the reaction plane and a magnetic quadrupole singlet placed between the target and the spectrograph magnet to enhance the solid angle and to correct for Doppler (kinematic) broadening of the image. Doppler correction is obtained when the quadrupole lens is rotated through a small angle so that force components are introduced that aid the dipole magnet in achieving a focus. This instrument was tested by studying the elastic scattering of 5.5-MeV protons from thin foils of gold and copper at the MIT-ONR Van de Graaff accelerator facility. A solid angle $\Omega = 32$ msterad and a resolving power $E/\Delta E = 920$ were measured, and evidence of the Doppler correction was clearly observed. (auth)

19935 COMPTON POLARIMETER FOR NEUTRON CAPTURE GAMMA-RAYS. Kajfosz, J. (Inst. of Nuclear Research, Prague). Nucl. Instrum. Methods, 51: 172-4(1967).

A modified version of the Compton polarimeter design for directional-polarization correlation studies of neutron capture gamma rays is described. By means of it a considerable increase of the coincidence counting efficiency was obtained. (auth)

19936 A DRIFT CURRENT CONTROL FOR GERMANIUM DETECTOR PREPARATION. Thompson, A. C.; Dalby, D. A. (Univ. of British Columbia, Vancouver, Can.). Nucl. Instrum. Methods, 51: 178-80(1967).

A simple, inexpensive control circuit and drift unit for constant-power-drifted planar detectors are described. A unijunction transistor oscillator controls an SCR and offers adjustable maximum temperature and sensitivity. (auth)

19937 COINCIDENCE-ANTICOINCIDENCE GAMMA-RAY SPECTROSCOPY WITH A NaI(Tl) SPLIT ANNULUS AND A Ge(Li) DETECTOR. Auble, R. L.; Beery, D. B.; Berzins, G.; Beyer, L. M.; Etherton, R. C.; Kelly, W. H.; McHarris, Wm. C. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods, 51: 61-71(1967).

A versatile gamma-ray spectrometer system consisting of a Ge(Li) detector surrounded by a large (20.3 cm × 20.3 cm) split NaI(Tl) annulus is described, and experimental results are presented as examples of its use in a number of coincidence and anticoincidence experiments. The annulus as a whole was used as an anti-Compton spectrometer and was found to reduce the Compton backgrounds in the Ge(Li) detector considerably. When the optically isolated halves of the annulus were used separately, the system was found to be very efficient for triple-coincidence experiments and as a pair spectrometer. As the latter, it yielded double-escape spectra having essentially no underlying backgrounds, even when used with complex gamma-ray emitters such as ^{56}Co. It was also very effective in determining relative β^{+} feedings to various levels in the decay of positon emitters. When the system was used as a coincidence spectrometer with narrow gates set on the pulses from the annulus, the Compton backgrounds of coincident gamma-rays detected in the Ge(Li) detector were reduced significantly. (auth)

19938 A LARGE COAXIAL Ge(Li) DETECTOR WITH PLASTIC ANTICOINCIDENCE SCINTILLATOR FOR ACTIVATION ANALYSIS. Cooper, R. D.; Brownell, G. L. (Massachusetts Inst. of Tech., Cambridge). Nucl. Instrum. Methods, 51: 72-6 (1967).

A gamma ray spectrometer was constructed which makes use of a Ge(Li) detector with 35 cm^3 active volume surrounded by a plastic scintillator annulus for Compton suppression. Efficiencies between 0.1 and 1 percent are obtained with resolutions between 6 and 7 keV. Compton suppression of about a factor of two is obtained. (auth)

19939 TIME-OF-FLIGHT PARTICLE IDENTIFICATION SYSTEM. Blignaut, E. (Southern Universities Nuclear Inst., Faure, South Africa); McMurray, W. R.; Bottega, A. Nucl. Instrum. Methods, 51: 102-8(1967).

A particle identification system for use in the study of nuclear reactions is described. It consists of a single semiconductor detector used in conjunction with the pulsed beam of a Van de Graaff accelerator. Particles are identified by using an analog pulse multiplier to compute the mass dependent function Et^2 where E is the particle energy and t the time of flight from target to detector. The design and performance of the system are discussed. (auth)

19940 WALL EFFECT CORRECTIONS IN PROPORTIONAL COUNTER SPECTROMETERS. Snidow, N. L.; Warren, H. D. (Babcock and Wilcox Co., Lynchburg, Va.). Nucl. Instrum. Methods, 51: 109-16(1967).

The measurement of neutron spectra using proton recoil spectrometers sometimes requires wall effect corrections. An accurate method is presented of calculating the wall effect, when measuring an isotropic neutron flux, for a spherical counter without a dead region and for a finite-length cylindrical counter either

with or without a dead region at each end. Analytical expressions are obtained for four path length probability functions, in which the geometric aspects are handled in an exact manner. The path length probability functions and range data are applied to proton recoil spectrometers to determine the energy lost in the sensitive region by protons starting in either the dead region or the sensitive region and stopping in the gas or hitting the wall. (auth)

19941 ABSOLUTE ALPHA COUNTING OF URANIUM IN A LIQUID SCINTILLATOR. Stoicovici, S.; Uray, I. (Institutul de Igiena, Cluj). Nucl. Instrum. Methods, 51: 25-8(1967).

A method for the measurement of the alpha radiation of natural uranium from a uranyl nitrate solution mixed with a toluene-base liquid scintillator is described. The alpha detection efficiency is 100% in the 14-90 gamma U range and the standard error is comprised between 4 and 9%. The method is a simple one and permits the measurement of concentrations three times lower than the maximum allowable dose of uranium in urine. (auth)

19942 THE UNIVERSITY OF UTAH NEUTRINO DETECTOR. I. CYLINDRICAL SPARK COUNTERS. Keuffel, J. W.; Parker, J. L. (Univ. of Utah, Salt Lake City). Nucl. Instrum. Methods, 51: 29-42(1967).

A cylindrical spark counter (CSC) was developed as an element of the Utah neutrino detector. A typical counter is 15 cm in dia and 11 m long with an 0.25-mm center wire. A gas mixture of $^2/_3$ argon and $^1/_3$ ethylene at a total pressure of 750 Torr results in a discharge sharply localized at the location of the initial ionization. Operation in the pulsed mode (6000-V clearing potential and 1.5-μsec, 2000-V pulse) makes possible economies in construction and permits use of a sonic ranging system to locate the discharges with a precision of 3 mm. Several discharges can occur simultaneously at different positions in the counter. A prototype detector containing 115 CSC operated for 6 months, demonstrating the stability and long life of the CSC and the ability of an array of them to give 3-dimensional representations of muon trajectories through the array. (auth)

19943 THE UNIVERSITY OF UTAH NEUTRINO DETECTOR. II. LARGE AREA DIRECTIONAL CHERENKOV DETECTORS. Hilton, L. K.; Morris, M. L.; Stenerson, R. O. (Univ. of Utah, Salt Lake City). Nucl. Instrum. Methods, 51: 43-6(1967).

Cherenkov detectors of large uniform sensitive area were economically constructed at the University of Utah to provide a highly efficient directional trigger for a hodoscope of pulsed cylindrical spark counters. The detectors are water filled concrete tanks having inside dimensions of 3 × 10 × 20 [ft], whose two large walls support a grid-like array of light collecting elements. A fraction of the Cherenkov light produced by a fast muon traversing the tanks is intercepted and trapped by the light collecting elements, the trapped light waveshifted to the blue and sensed by photomultiplier tubes located at the end of each light collector. The output from the array for a single fast muon corresponds to ~16 photoelectrons, giving the light collection system an overall efficiency of 1%. The two Cherenkov tanks operated in coincidence incorrectly determine the direction of a particle traversing them only once in 100,000 times. (auth)

19944 THE UNIVERSITY OF UTAH NEUTRINO DETECTOR. III. DATA HANDLING SYSTEM. Bergeson, H. E.; Wolfson, C. J. (Univ. of Utah, Salt Lake City). Nucl. Instrum. Methods, 51: 47-55(1967).

A data-handling system designed for use with the Utah neutrino detector is described. This system is capable of handling a large number of cosmic-ray events, each having many parameters, and yielding the data in a digital form suitable for direct analysis on a computer. The entire system, although composed of inexpensive transistors and commercial-type integrated circuits, has worked reliably in a prototype detector for six months. (auth)

19945 INFLUENCE OF THE SOURCE-ABSORBENT GEOMETRY ON THE EXPERIMENTALLY DETERMINED MOESSBAUER SPECTRUM PARAMETERS. Nistor, C. (Univ., Bucharest); Tinu, T. Rev. Roum. Phys., 11: 551-8(1966).

The form of the velocity dispersion in the Mössbauer absorption experiment is given for the case when the source, the absorber, and the detector are homogeneous coaxial disks. For this case, tables with geometrical corrections of the Mössbauer spectrum parameters are also given. (auth)

19946 HODOSCOPE INSTRUMENTATION FOR PHOTOPRODUCTION OF WIDE ANGLE MU MESON PAIRS. PART I. DETECTORS AND HODOSCOPE ELECTRONICS. Gettner, M. (Northeastern Univ., Boston); Weinstein, Roy; Boyarski, A. M.; Glass, G. Contract AT(30-1)-2098. Nucl. Instrum. Methods, 51: 1-12(1967).

A 192 counter hodoscope was used in an experiment on photoproduction of mu meson pairs utilizing a 5.2 GeV bremsstrahlung beam at the Cambridge Electron Accelerator. The hodoscope detectors are described. The logic and circuitry up to and including intermediate storage of hodoscope detector information on flip-flops is discussed. Reliability data, production techniques and costs are reported. (auth)

19947 HODOSCOPE INSTRUMENTATION FOR PHOTOPRODUCTION OF WIDE ANGLE MU MESON PAIRS. PART II. CONTROL-INTERFACE UNIT. Boyarski, A. M. (Massachusetts Inst. of Tech., Cambridge); Weinstein, Roy. Contract AT(30-1)-2098. Nucl. Instrum. Methods, 51: 13-17(1967).

The data collected from a 192 counter hodoscope is temporarily stored, as described in Part 1, on flip-flops, connected as six shift storage registers. In Part 2 the fixed program device which takes over control of the experiment once the flip-flops are loaded is described. This device, which serves the functions of a control unit for the hodoscope and an interface between the hodoscope and the tape recorder, transfers the data to a tape recorder in proper IBM binary format. The requirements of IBM format and the consequent requirements on the timing and nature of the command sequence of the control-interface unit are discussed. (auth)

19948 HODOSCOPE INSTRUMENTATION FOR PHOTOPRODUCTION OF WIDE ANGLE MU MESON PAIRS. PART III. ON-LINE DATA READOUT AND CHECKING. Weinstein, R. (Northeastern Univ., Boston); Boyarski, A. M. Contract AT(30-1)-2098. Nucl. Instrum. Methods, 51: 18-24(1967).

The use of a magnetic tape recorder is discussed for the start-stop mode of operation in which the recorder is started for each event and stopped after the recording of the event. The amount of data recordable in this mode and the limitations upon its use are considered. A fixed program on-line readout and data-checking device is described which is suitable for use with tape recorded data from a hodoscope of several hundred counters. The device may be used visually to display the events or as a quantitative check on the operation of each hodoscope detector. The data may be read from tape immediately after being written or at a later time under control of the checking unit. (auth)

19949 CHARACTERIZATION OF GEOMETRIC IMAGING PROPERTIES OF GAMMA-RAY DETECTORS. Vetter, H. G. (Massachusetts General Hospital, Boston). Int. J. Appl. Radiat. Isotop., 18: 231-5(Apr. 1967).

The relative advantages of describing imaging properties of γ-ray detectors by their rigorous spread functions or by a single index are discussed. It is shown that in the statistical context of radioisotope imaging a single index can fairly characterize any spread function within a wide range of shapes, provided this index is based on the concept of flux. Such an index is shown to correspond closely to the subjective impression of image quality perceived by an observer. It permits the computation, by a simple formula, of the resulting index for a multiple imaging process involving spread functions of different shapes. (auth)

19950 LIQUID SCINTILLATION COUNTING: A NEW PROCEDURE FOR DETERMINING COUNTING EFFICIENCY. Caddock, B. D.; Davies, P. T.; Deterding, J. H. (Shell Research Ltd., Chester, Eng.). Int. J. Appl. Radiat. Isotop., 18: 209-14 (Apr. 1967).

A new approach is presented for correcting for quenching in liquid scintillation counting with a two-channel instrument. The square root of the number of counts in one channel is taken as a function of the square root of the counts in the other channel. This has the advantages over the widely used channels ratio method that a statistically valid numerical interpretation replaces the graphical one, and that an estimate of the precision of each activity is given. The method is designed for computer evaluation of data from an automatic liquid scintillation counter. (auth)

19951 LIQUID SCINTILLATION COUNTING OF AQUEOUS ^{3}H- AND ^{14}O-PROTEIN SOLUTIONS AT ROOM TEMPERATURE. Francis, G. E.; Hawkins, J. D. (St. Bartholomew's Hospital, London). Int. J. Appl. Radiat. Isotop., 18: 223-30(Apr. 1967).

A method is described for liquid scintillation counting of aqueous protein solutions at room temperature using conventional organic phosphors (PPO and POPOP) (2,5-diphenyl oxazole and 2,2′-p-phenylene-bis [5-phenyl-oxazole]) dissolved in 2-phenylethylamine or mixtures of 2-phenylethylamine and toluene. These phosphors will tolerate water up to 60 per cent of their volume, protein concentrations up to 20 mg/ml, and have counting efficiencies which are largely independent of their water or protein content. Many electrolytes and buffer salts are also soluble in the scintillator. Details are given of the application of the channels ratio quench correction method to a single pulse height channel system by altering the voltage applied to the photomultipliers. (auth)

19952 NEW SHIELD FOR GAMMA-RAY SPECTROMETRY. Brar, S. S.; Nelson, D. M.; Gustafson, P. F. (Argonne National Lab., Ill.). Int. J. Appl. Radiat. Isotop., 18: 261-5(Apr. 1967).

A gamma-ray shield was designed and constructed having the unique property that it can be evacuated, refilled with a clean gas, and pressurized to exclude airborne radioactive contaminants. It is found that, under working conditions, repeated evacuation and filling procedures have no ill effect on the NaI(Tl) crystal detector, its resolution and sensitivity remaining unchanged provided the crystal is jacketed with $^3/_{32}$-in. stainless steel and the evacuations are carried out to half an atmosphere. The crystal temperature inside the shield came to a rapid equilibrium after the shield was evacuated several times and pressurized with carbon dioxide. (auth)

19953 A SIMPLE TEMPLATE FOR V^0 DECAYS. Laakso, I. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 48A: 237-8(Mar. 1, 1967).

The design of the template for assigning the originating vertex for V^0 decays photographed on bubble chamber film is given. The performance of this template is also described for K^0 decays. (auth)

19954 DETERMINATION OF THE FANO FACTORS FOR Ge(Li) DETECTORS. Ruge, Ingolf; Eichinger, Peter (Technische Hochschule, Munich). Z. Naturforsch., 21a: 2083-8(Dec. 1966). (In German).

Within the last two years the Fano factor F for Ge(Li)-detectors, which defines the theoretical limit for the resolution in the area of spectroscopy in regard to the detector, was found out experimentally several times. The values obtained for F vary between 0.7 and 0.15. In order to find out the reasons for these variations the dependence of the energy resolution on the electric field was examined at various gamma-energies for several Ge(Li)-detectors. Even at very high electric fields (several kilovolts/cm) still a field dependence especially at high gamma-energies appeared, which could be explained in terms of charge collection time. As condition for an exact determination of the Fano factor the extrapolation of the resolution to field strength infinity is set up; with this method the value of the Fano factor for Ge(Li)-detectors, used here, was estimated to 0.20 ± 0.05. (auth)

19955 TRANSFER OF THE NBS ABSOLUTE CALIBRATION FOR MEASUREMENT OF HIGH-ENERGY ROENTGEN RADIATION BEAMS. Thoraeus, R. (Karolinska Sjukhuset, Stockholm). Acta Radiol., Therapy, Phys., Biol., 4: 459-70(Dec. 1966).

Three identical ionization chambers of the special type developed by the National Bureau of Standards and labeled P2 have been constructed to transfer the NBS absolute calibration for determination of the total amount of energy transported by high-energy roentgen radiation beams. Some characteristics of the Swedish replica chambers are discussed. (auth)

19956 ON THE LINE FORM OF NaI(Tl) PAIR SPECTROMETERS. Krueger, H.; Abu-Zeid, H. M.; Fiebiger, N. (Univ., Frankfurt am Main). Nukleonik, 9: 77-84(Feb. 1967). (In German).

A five-crystal pair spectrometer, which is an improvement compared to the usual three-crystal pair spectrometers with regard to spectral response and efficiency, was investigated. An analytic expression was found, which describes the spectral response function with good accuracy and also applies to three-crystal pair spectrometers. The parameter values of the spectral response function of the five-crystal pair spectrometer were determined by least-squares fits from (n_{th},γ) calibration spectra and are stated to be independent of the source-detector geometry. (auth)

19957 USING THE BORON FILTER METHOD FOR MEASURING THE SPECTRUM OF NEUTRONS IN A COLLIMATED BEAM. Egorov, O. K.; Konstantinov, L. V.; Postnikov, V. V. pp 117-19 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Filters of various thicknesses were placed in the path of a collimated beam of neutrons, and the particles passing through these filters were recorded to give a system of equations for determining integral neutron fluxes. This method is used for determining the spectrum of neutrons in a collimated beam from the core surface in a water-water reactor type IRT-1000. The detector was an "all-wave" neutron counter with a sensitivity which is practically constant over a wide energy range. The filters were amorphous boron. Since the deviation cross section for boron shows resonance at high energies, the continuous spectrum for neutrons may be obtained only at energies below 0.4 MeV, corresponding to the first resonance level. The filters were placed at the beam exit and the counter was located 4 m from this exit. A 1-mm sheet of cadmium was placed in front of the filters to eliminate thermal neutrons. The transmission curve was used to determine the integral neutron fluxes on the basis of the given equation in energy ranges of 0.4 to 200 eV, 200 to 10^5 eV, 0.1 to 2 MeV, and 2 to 10 MeV. The resultant spectrum is compared with those obtained by the Laplace transform method and by 18-group calculation of the neutron spectrum at the core boundary. (ATD)

19958 GENERALIZED FOIL-ACTIVATION METHOD OF DETERMINING NEUTRON FLUX-SPECTRA FOR RADIATION EFFECTS STUDIES. McElroy, William Nordell. Chicago, Illinois Inst. of Tech., 1965. 397p.

Thesis.

The need for the proper definition of neutron environments and its importance to radiation effect studies are discussed. In view of this need, new methods of foil activity data reduction are suggested and subjected to mathematical and numerical analysis. Non-iterative, single-iterative, multiple-iterative, series expansion, and effective cross section methods of foil data reduction are discussed and compared. A generalized method of foil activity data reduction is suggested that makes use of the non- and multiple-iterative procedures. The study investigates the difference between the true and derived approximation to the unknown spectrum for the energy range of 4×10^{-7} to 18 MeV. The analytical implication of the results is that integral flux values that are accurate to 5% can be obtained with a small set of properly selected foil detectors. When the errors in the measured cross section data and activity are included, however, it is found that the accuracy is limited to 10 to 30%. The work shows that there is need for a better definition of neutron environments for radiation effect studies. Advanced methods of foil activity data reduction were developed and suggested to help meet this need, and the investigation pointed out the requirement for an increased effort to obtain better cross-section data and to improve the accuracy of foil activity measurements. (Dissertation Abstr.)

19959 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON RADIATION MEASUREMENTS IN NUCLEAR POWER, BERKELEY NUCLEAR LABORATORIES (C.E.G.B.), GLOUCESTERSHIRE, ENGLAND, SEPT. 1966. Conference Series No. 2. London, The Institute of Physics and The Physical Society, [1967]. 455p. 5 Pound. (CONF-660911).

Separate abstracts are prepared for 43 of the 56 papers presented. Two papers were previously included in NSA. For abstracts of these papers see Conf: 660911. Eleven papers were in summary form and were not abstracted for NSA. (B.G.D.)

For abstracts of individual papers see: 19960–19971, 19979, 20003–20006, 21359, 21391–21394, 21432, 21469, 21503, 21504, 21678–21687, 21788–21792, 21809, and 21810.

19960 NEUTRON-CHOPPER TIME-OF-FLIGHT SPECTRUM MEASUREMENTS ON UNDERMODERATED GRAPHITE AND BERYLLIUM SYSTEMS. Hardiman, J. P.; Jakeman, D.; Maunders, E. J.; Ross, D. K.; Travis, A. J. B. (Atomic Energy Establishment, Winfrith, Eng.). pp 63-73 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

A description is given of the time-of-flight equipment which was used to investigate the lower energy regions of the neutron energy spectrum in subcritical assemblies fuelled with plutonium and enriched uranium and moderated by beryllia and graphite. These measurements form part of a general study of undermoderated systems in which fission takes place predominantly at energies above 0.1 ev and are intended to verify that the reactivity contribution, in the region where the scattering law of the moderator is important, is being predicted correctly by the theoretical models. In addition to the design considerations, the characteristics of the chopper under operating conditions are outlined with a description of the experiments which were carried out to verify that meaningful results are being obtained. Observed neutron spectra in a number of assemblies are compared with theoretical predictions using a multigroup transport code. (auth)

19961 NEUTRON RETHERMALIZATION STUDIES IN LIQUIDS USING MINIATURE FISSION CHAMBER DETECTORS. Tremeer, G. E. B.; Goddard, A. J. H.; Grant, P. J. (Imperial Coll. of Science and Tech., London). pp 80-6 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

Miniature ^{235}U and ^{239}Pu fission chambers were used to separate the space and energy variations in neutron density in the region of a plane interface between a tank containing room-temperature water and a tank containing hot organic liquid, Santowax-R. A cadmium-shutter technique was used to simulate a purely thermal-neutron source and an attempt was made to detect γ-ray-induced photofissions in the fission chambers. Methods used to monitor

temperature-induced gain changes and to record reactor power fluctuations are discussed. Examples are given to illustrate the two types of analysis of results that are currently in use, namely the two overlapping thermal-group and multi-group transport theory methods. (auth)

19962 TECHNIQUES WITH RESONANCE FOIL SANDWICH DETECTORS. McCracken, A. K. (Atomic Energy Research Establishment, Harwell, Eng.). pp 168-78 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The measurement by foil sandwich methods of epithermal neutron spectra is relatively simple in materials whose neutron cross sections have no resonances which coincide with those of the detectors. The basis of this type of measurement is discussed briefly and neutron spectra at various distances into a tank of sodium are shown. Problems associated with the use of foil sandwiches in ducts, where the neutron flux angular spectrum may be highly anisotropic, are discussed. The simultaneous irradiation in equivalent positions of a two-foil and a three-foil assembly makes possible a reasonable estimate of the resonance neutron current leaving the walls of a duct. Both the angular flux and the scalar resonance flux at points on the axis are then simply found. Measurements of this type, designed to lend support to an iterative method of calculation, are described, together with the results of the calculations. The use of sandwich detectors in environments where cadmium filters are not permissible is considered and it is shown that reasonable accuracy in resonance flux measurement can be achieved in energy spectra which do not differ too markedly from that during calibration. Some problems associated with sandwich measurements in fast reactor environments are discussed and measurements are described. (auth)

19963 FAST-NEUTRON SPECTROMETRY WITH THICK ORGANIC SCINTILLATORS IN REACTOR-TYPE MEASUREMENTS. Verbinski, V. V.; Burrus, W. R.; Freestone, R. M.; Textor, R. E. (Oak Ridge National Lab., Tenn.). pp 220-30 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

Fast-neutron spectrometry with thick organic scintillators is described, including circuit design, detector calibration, construction of a response matrix, and unscrambling the pulse-height distribution to obtain the absolute neutron flux against energy. Pulse-shape discrimination was used to eliminate gamma-ray events for 0.035 to 10 MeV electron energy. This corresponds to a range in pulse heights produced by recoil protons of 0.4 to 20 MeV and to a range of neutron energies of 0.7 to 20 MeV after unscrambling. The γ/neutron count rate ratio was as high as 10:1 for these tests. For an experimental reactor beam, where the γ/neutron count ratio was at least five times higher, the pulse-shape discriminator bias had to be raised and the lower energy limit of the neutron spectrum after unscrambling was thereby pushed up to about 1 MeV. Improvements in the gamma-ray tolerance and the tolerance to high γ/neutron ratios are important for the spectral mapping of a reactor core. A few modifications of the spectrometer are outlined for achieving these improvements. (auth)

19964 NEUTRON SPECTRUM MEASUREMENTS IN THE ZERO POWER FAST REACTOR VERA. Weale, J. W.; Benjamin, P. W.; Kemshall, C. D.; Paterson, W. J.; Redfearn, J. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). pp 231-44 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The techniques used for neutron spectrometry on the VERA reactor are proton-recoil measurements in photographic emulsion (energy range 0.5-5 MeV), proton-recoil measurements in a hydrogen-filled proportional counter (energy range 1 keV–1 MeV), and time-of-flight measurements using a pulsed neutron source (energy range 10 eV-50 keV). Some recent developments of these techniques and their application to the fast reactor assemblies VERA 7A, VERA 16Z5A and VERA 17Z5J are described. Emphasis is on the importance of establishing the reliability of the results by making absolute measurements with the different detectors and by checking the experimental spectra against fission ratio measurements and against measurements with a $^6Li(n,\alpha)$ semiconductor counter. For assembly VERA 17Z5J, the low-energy region of the spectrum was measured by the time-of-flight method and by the proportional counter method using pulse-shape discrimination. Some significant discrepancies were noted, but in general it appears that in a period of 1 or 2 years these techniques could be developed to yield a demonstrable accuracy to ±5% for fast reactor spectrometry. (auth)

19965 ON THE DATA HANDLING PROBLEM IN FAST NEUTRON SPECTROMETRY. Deckers, H. R. (Studiecentrum voor Kernenergie, Mol-Donk, Belg.). pp 259-69 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The data handling problem in any method of fast neutron spectrometry based on the measurement of some parameter related to the products of some nuclear interaction can be formulated in the same way. The resulting relation must be converted into a system of simultaneous linear equations if numerical results are to be obtained. To this end the neutron spectrum is developed a priori in a linear combination of elementary distributions. The resulting matrix can then be used either for the calculation of the response of theoretical neutron spectra or in a direct inversion method. For the $^6Li(n,\alpha)^3H$ reaction the corresponding matrices are calculated for the following parameters: the triton energy E_T (corrected for the alpha particle), the combined range $l_T + l_\alpha$ in nuclear emulsion and the triton–alpha angle ψ. The elementary distributions are either of the rectangular or of the delta-function type. A least-squares direct inversion method is proposed and the neutron spectrum is calculated for an experimental E_T distribution and for a (fictitious) experimental ψ distribution. A Monte Carlo study is presented of the influence on the calculated spectra of errors in the detector response matrix, the assessment being made by introduction of random errors into the matrix. (auth)

19966 EVALUATION OF FLUX DISTRIBUTION BY AUTOMATIC COUNTING OF LARGE SETS OF ACTIVATION DETECTORS. Borchardt, G.; Hasenclever, B.; Schneider, W. (Kernforschungsanlage, Juelich, Ger.). pp 391-6 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

A counting installation is described, which automatically measures up to 50 activation detectors and provides the data on punched tape that can be fed directly into an electronic computer. By comparison of the count rates in three counting positions with two opposite detectors the results are very reliable. The installation is controlled by preset time or by preset count from a monitor counter. The operation mode is very flexible. The design philosophy of the sample changer and the electronic equipment is described, and the requirements for the computer program are discussed. Particulars of the program are given. (auth)

19967 FAST-NEUTRON MONITOR UTILIZING HELIUM PRODUCTION IN BERYLLIUM. Cartwright, D. K.; Hamer, A. N.; McKnight, J. A. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 397-407 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

A fast-fluence monitor, relying on the production of helium in beryllium, is being evaluated. Two fast-neutron reactions in beryllium, namely (n,2n) and (n,α), combine to give an average fission-neutron cross section of 282 mbn for helium production. The effective threshold is about 2.8 MeV. Measurement of the helium produced is achieved by melting the irradiated beryllium in vacuo and analysing the gases released by means of mass spectrometry. Measurements on irradiated samples suggest that as few as 5×10^{15} atoms of helium can be determined to a coefficient of variation of 0.7%. The loss of helium from beryllium wire of 1.6 mm diameter has been investigated by irradiating samples at low temperatures and subsequently heating them in the laboratory. The loss is consistent with a diffusion mechanism, and rises to 1% per annum at a temperature of 750°C. The advantages of this monitor rest in the wide range of fluences that it can measure. Although the minimum measurable fluence is about 10^{16} neutrons/cm^2 there would appear to be no practical upper limit to both fluence and length of irradiation, apart from that imposed by temperature. Interfering reactions from impurities present no problem. ^6Li from the fast-neutron (n,α) reaction in beryllium itself burns up from a thermal-neutron (n,α) reaction. A rough estimate of thermal fluence is sufficient to correct measurements. The limitation to the use of the monitor comes from the interfering (γ,n) reaction in beryllium. This prevents the attainment of reliable measurements in certain circumstances, for example near a reactor pressure vessel. Irradiation tests of the monitor have been made in the Windscale advanced gas-cooled reactor (W.A.G.R.), in a Belgian reactor (BR2), and in the Dounreay materials testing reactor (D.M.T.R.). (auth)

19968 WIDE-RANGE NEUTRON FLUX MEASUREMENT AT HIGH TEMPERATURE. Goodings, A. (Atomic Energy Establishment, Winfrith, Eng.). pp 408-19 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The thermal neutron measurement problems which arise in the instrumentation of concrete pressure vessel gas-cooled reactors are discussed and solutions which are being evolved noted. Two new ionization chambers are considered in some detail, a fast counting pulse fission counter and a gamma-compensated boron dc chamber. The physical and engineering basis of both designs is discussed with emphasis on the limitations and difficulties associated with gamma-compensated devices and the problems of obtaining adequately high insulation resistances. (auth)

19969 DESIGN AND PERFORMANCE OF MINIATURE PRIMARY EMISSION NEUTRON ACTIVATION DETECTORS FOR SPATIAL DISTRIBUTION MEASUREMENTS OF NEUTRONS IN REACTORS. Loosemore, W. R.; Knill, G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 430-9 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

Details are given of the design and performance of small primary emission neutron activation detectors for in-core flux monitoring up to 2×10^{14} neutron/cm^2/sec and 500°C. Detectors with 3 cm long rhodium emitters (0.5 and 1 mm diameter) and overall diameters of 1.5 and 2.4 mm have extrapolated neutron sensitivities of 4×10^{-21} and 7×10^{-21} A per neutron/cm^2/sec, respectively. The measured rates of reduction in output current for these detectors due to depletion of the emitter material, in a thermal-neutron flux intensity of 10^{14} neutron/cm^2/sec, are 2.8 and 2.0% per 30 days, compared with calculated rates of 3.1 and 2.5%. Results so far extend to a total irradiation of 2.42×10^{21} neutron/cm^2. The detectors are welded to 1.5 mm diameter magnesia-insulated stainless-steel sheathed cables having two twisted inner conductors to compensate for background effects. (auth)

19970 ACTIVATION METHODS FOR UNDERMODERATED REACTORS. Stanford, G. S. (Argonne National Lab., Ill.). pp 440-8 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

At Argonne National Laboratory extensive activation and power-distribution measurements are routinely made in conjunction with critical experiments. Most of the neutron activation studies have been made with foils of dysprosium, indium, gold, manganese, copper, and uranium. Uranium–aluminum wires are used for measuring localized power peaks. Most of the recent cores studied have been undermoderated, so that the Westcott formalism has not been applicable in analysing the results. Counting equipment and techniques for foils and wires are discussed, including such considerations as accuracy, dead-time corrections, and data processing. The activated foils are counted in automatic systems. There are two detectors per sample changer, with each detector feeding up to three amplifiers and scalers. The two detectors, located above and below the foil, permit first-order cancellation of the effects of small vertical displacements in the foil positions, and the redundancy in the subsequent circuitry has proved useful in preventing the loss of data owing to malfunction of one of the electronic components. For computer processing the counting data are automatically punched on IBM cards. The influence of self-shielding on weight correction methods and of the dysprosium substitution method for determining cadmium ratios that are close to unity is also discussed. (auth)

19971 TECHNIQUES FOR PROCESSING LARGE QUANTITIES OF FOIL COUNTING DATA. Stanford, G. S. (Argonne National Lab., Ill.). pp 376-82 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

Critical experiments tend to generate such large quantities of foil counting data that it is advantageous to automate the data handling as much as possible. Some of the ways by which this is being done at Argonne National Laboratory are discussed. The counting data, automatically punched on IBM cards, are first processed by one of two codes (RP-202 or NURF) which make decay and other corrections. For cases where all the foils of a particular set cannot be counted together, further combining and internormalizing functions are performed by the COMBO code. The NURF code is discussed in some detail. In order to make decay corrections for a set of fission foils, the traditional method has been to count simultaneously a reference foil irradiated along with the others; although this method gives satisfactory results, it has in practice several drawbacks. NURF permits dispense with the reference foil, provided that each foil of the set is counted several times. It converts the counting rates and elapsed times (after irradiation) to logarithms and synthesizes a decay curve by means of a least-squares polynomial fit. This step is iteratively alternated with a step in which the set of counts of each foil is multiplied by the factor which causes that set best to fit the previously found curve. The results of this program agree, within counting statistics, with those of the more cumbersome reference-foil method. (auth)

19972 PLUTONIUM AIR MONITOR (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1557).

66 drawings.

A solid state plutonium air monitor which monitors and records plutonium in air is described. Alpha activity is detected with a silicon surface barrier detector and a signal channel analyzer selects the desired energy level. The activity is rate counted, combined with an alarm monitor to trigger an audible alarm at a predetermined level. The solid state detector is mounted on the charge preamplifier for low capacitance and low noise input. The charge preamp is mounted inside the detector holder and is easily accessible. The pulse amplifier, count rate and alarm monitor, and differential discriminator are plug-in printed circuit boards. The audible alarm has a loud, irritating wobbling sound, to alert the operator in high noise background areas. The unit requires externally 1 to 2 cubic feet per minute constant air flow. Most inhouse vacuum systems will meet this requirement. At this air flow 1 MPC of plutonium-239 can be detected within 8 hours. (For details see TID-4100 Suppl. 39). (auth)

19973 UNIFORMLY MOST POWERFUL SIMILAR TESTS FOR DETECTING RADIOACTIVE DECAY. Wood, Ross Joseph. Minneapolis, Univ. of Minnesota, 1965. 92p.

Thesis.

In many low-level radioactive counting studies the radionuclides of interest are either present only in trace quantities, or totally absent. The initial objective is often a decision concerning merely the absence or presence of short-lived material. The most commonly used decision procedure is based on a series of fixed-time experiments for which the observed sequence of counts is examined for evidence that the number of counts is a decreasing function of time. Asymptotic infinite model techniques form the basis of such analyses. A formal procedure is obtained for deciding that short-lived material is absent or that it is present. Exact finite model techniques are employed to develop a decision procedure based on one single-stage experiment. UMP similar rules in the form of statistical tests are derived for each of three stopping rules, viz., fixed time-random count, random time-fixed count, and random time-random count. The resultant tests have a common form in that the test statistic in each case is a normalized sum of an ordered set of the observations. Consequently a single table of critical values serves for all three stopping rules. To facilitate the application of the tests an extensive table of critical values is given for three levels of significance. A means of evaluating the test procedures is provided in the form of conditional power curves graphed over points computed from conditional power functions. The unconditional power function for each stopping rule is obtained and two distinct bases for comparing the three stopping rules are defined. The utility of the UMP similar rules is illustrated by application to data obtained in a bona fide low-level radioactive counting study. (Dissertation Abstr.)

19974 IMPROVEMENTS IN METHOD AND APPARATUS FOR MEASURING RADIATION. (to General Electric Co.). British Patent 1,061,535. Mar. 15, 1967. Priority date Sept. 11, 1963, United States.

A dosimeter is described which comprises of a material permeable to damage-track-producing fission fragments and a fissile material such as natural uranium, uranium-235, uranium-238, thorium, or mixtures of these materials. The dosimeter is of the personnel film-badge type and is used to measure radiation doses from thermal and fast neutrons and fast gamma rays. (B.G.D.)

19975 SURFACE BARRIER DETECTORS. Kaufmann, Claus (to Zentralinstitut fuer Kernphysik). British Patent 1,057,761. Feb. 8, 1967. Filed Jan. 14, 1964.

The fabrication of silicon surface barrier detectors wherein the surface barrier detector is made by surface etching p-conducting silicon, treating the etched surface with an additional chemical media, and then applying a gold vapor on it. (B.G.D.)

Radiation Dosimeters

19976 (CERN-66-33) EXPERIENCE WITH A LINEAR ENERGY TRANSFER (LET) CHAMBER AT CERN. Overton, T. R. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct. 24, 1966. 39p. Dep. mn.

The performance of a spherical cavity proportional counter with tissue-equivalent walls filled with tissue-equivalent gas at low pressure for measurement of the linear energy transfer spectra of irradiated biological materials is described. Design modifications in the counter are discussed. Results are reported from measurements of the LET-dose spectra of neutrons, protons, and pions (π^- and π^+) using various absorber thicknesses and experimental conditions. (C.H.)

19977 (PPAD-611-E) EXPERIENCE WITH COMMERCIAL FILM BADGE SERVICE. Schimmerling, W.; Sass, R. E. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Jan. 30, 1967. Contract AT(30-1)-2137. 25p. (CONF-670115-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 1st Health Physics Society Mid-Year Topical Symposium on Personnel Radiation Dosimetry, Chicago, Ill.

The performance of commercially available film badge dosimeters for personnel monitoring was studied over a period of three years. Known doses were administered to a group of film badges and the results analyzed. The commercial film badge service's neutron film doses were statistically checked for accuracy, reproducibility, and for any effects due to fading of the neutron tracks. In addition, preliminary studies were made to determine which, if any, film packaging procedures were effective in retarding track fading. It was found that the reported exposures were somewhat higher than those actually given. The results for exposures over 100 mrem were reasonably reliable. Large uncertainties are inherent to lower exposures. Track fading is definitely a problem. Preliminary studies indicate that special packaging tried resulted in no noticeable improvement. The reliability of the beta-gamma film was studied in one instance by comparison of the film badge service's reported doses with known beta and gamma exposures given. Owing to the necessarily arbitrary level of separation of beta from very soft gamma exposures, the beta + gamma results were found to be more accurate than each separately, as was to be expected. The separate readings, however, also were acceptable. A further comparison was made of beta + gamma reported exposures and accumulated readings from pocket ionization chambers used at the Princeton-Pennsylvania Accelerator for auxiliary, day-to-day monitoring. Results are in reasonable agreement. It is concluded that the results of this commercial film badge service are acceptable within the limitations of the device itself. Problems which may arise due to personnel changes outside the user's control and of service continuity are discussed. Finally, the need for personnel monitors of improved sensitivity to intermediate energy neutrons is considered in the light of survey measurements made at the Princeton-Pennsylvania Accelerator. (auth)

19978 SURFACE CATALYTIC EFFECTS IN NITROUS OXIDE RADIATION DOSIMETRY. Lampe, F. W.; Kevan, L.; Weiner, E. R.; Johnston, W. H. (William H. Johnston Labs., Inc., Baltimore). Contract AT(30-1)-2901. J. Phys. Chem., 71: 1528-9(Apr. 1967).

In a study of dosimeters for a strontium β-irradiator it was found that complications from metal surface catalysis may arise in certain applications of nitrous oxide as a gas-phase radiation dosimeter. Nitrous oxide dosimetry produced N_2 yields an order of magnitude greater than expected from radiation decomposition. The N_2 yields were independent of N_2O pressures at 50 to 700 torr and were proportional to the time spent in the irradiator. The pressure-independent yields demonstrated that a mechanism other than radiation decomposition predominates and it was suggested that a surface catalytic mechanism could be operative. At high dose rates (greater than 10 Mrad/hr) no surface catalytic effects were significant and N_2O was a useful dosimeter. (D.H.M.)

19979 USE OF PASSIVE DETECTORS FOR THE EVALUATION OF NEUTRON SHIELDING. Gayton, F. M.; Hall, J. A.; Webb, G. A. M. (Berkeley Nuclear Labs., Eng.). pp 152-61 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The experimental evaluation of neutron shielding involves measurement of the high-intensity flux inside the reactor shield and also the generally low-intensity flux, with a large energy spread, outside the shield. Methods by which thermoluminescent lithium fluoride may be used to perform these measurements are described. For the examination of the intensity and spectrum of leakage fluxes a new type of instrument, the DELTA spectrometer, was developed. It uses lithium fluoride to determine the thermal fluence distribution along the axis of a cylindrical moderator irradiated on one face. The spectral information is obtained from the thermal fluence distribution by an iterative solution to a matrix equation containing the measured response to monoenergetic neutrons. This device covers nine decades of energy and is sufficiently sensitive to measure fluence levels of 10^6 neutrons/cm^2. Smaller moderating systems and resonance detectors using lithium fluoride to provide information in the intermediate neutron energy region were investigated. These may offer possibilities for measurements of high-intensity fluxes. (auth)

19980 SCINTILLATION DOSIMETER FOR GAMMA RADIATION OF RADIATION SENSITIVE GLASS. Guenter, G. G.; Siljeholm, G. E. V.; Skjoeldebrand, R. H. A. (to Forsvarets Forskningsanstalt). Swedish Patent 152,884. Feb. 9, 1967. Filed June 30, 1953. (In Swedish).

Radiometric Instruments

Refer to abstracts 19858, 19859, and 19876.

Miscellaneous Instruments and Components

Refer also to abstracts 19792, 19868, 19874, and 19944.

19981 (AWRE-O-98/65) A CRYSTAL NEUTRON MONOCHROMATOR. Reichelt, J. M. A. (Atomic Weapons Research Establishment, Aldermaston (England)). Dec. 1965. 16p. Dep. HMSO 2s. 6d.

A neutron monochromator which uses diffraction from an aluminum crystal is described. The instrument provides a beam of neutrons of 1.46 eV and has been used for radiographic measurements in conjunction with a resonance energy detector. The mosaic characteristics of large aluminum single crystals was investigated and these have led to an improvement in crystal growing technique, resulting in a single crystal with small mosaic spread. (UK)

19982 (CLOR-61/D) SOLID STATE ELECTROMETER AMPLIFIER FOR HEALTH PHYSICS INSTRUMENTATION. Katkiewicz, W. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 12p. Dep.

The Hitachi HS663A insulated gate n-channel MOSFET's were checked for electrometer applications. Input resistance of 10^{16} – 10^{14} ohms, minimum temperature coefficient of 0.4 mV/°C and long term drift 5 mV per 12 hours were observed. The simple electrometer amplifier for ionization chambers with current sensitivity of 10^{-13}A, for full deflection of motor, temperature drift 0.1 mV/°C, and long term drift 0.3 mV per 12 hours is described. (auth)

19983 (CONF-651154-3) MICROCALORIMETRES POUR MESURE D'ENERGIE NUCLEAIRE EN PILE. (Microcalorimeters for In-Pile Nuclear Energy Measurements). de Goer, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov. 3, 1965. 18p. (In French). Dep. mn.

From Symposium on Flux Measurements used in Connection with Irradiation Equipment in Research and Material Test Reactors, Grenoble, France.

After a review of the different questions caused by the measurement of the γ flux in irradiation devices in nuclear reactors, the microcalorimeter is chosen as being the apparatus best suited. A report of the problems concerning its startup and the use of the measurements, illustrated by concrete examples, shows that the precision attainable is of the order of 5%. (tr-auth)

19984 (CONF-660511-, pp 8,3,1-32) TESTING AND APPLICATION OF DETECTORS FOR MEASUREMENT OF DYNAMIC PHENOMENA DURING BURST IRRADIATION CAPSULE EXPERIMENTS.

Testing of irradiation capsules was performed to determine the consequences of test fuel failure resulting from the test fuel being subjected to high-energy, short-period nuclear transient irradiations. Capsule instrumentation consisted of a pressure transducer, strain gages, cobalt wires, thermocouples, and a growth ring on the fuel rod. The instruments must perform in radiation environments as high as 8×10^{16} nv (thermal) peak with ~ 10^{15} nvt integrated dose and 10^{12} R/hr peak with a total integrated dose of about 10^6 rads. The pressure environment may exceed 20,000 psi under shock pressure conditions with rise times of 10 μsec or less. Peak fuel temperatures may exceed 3000°C with a test duration of 500

msec. Detectors and their testing in and out of the radiation environment are described. (F.S.)

19985 (K-1692) SOLID STATE ELECTRONIC CIRCUITS FOR THE LINE RECORDER MASS SPECTROMETER. Kermicle, H. A.; Seaborn, G. B. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Apr. 10, 1967. Contract W-7405-eng-26. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

New electronic circuits have been developed for the mass spectrometer known as the Line Recorder. This instrument is used as an analytical and control device throughout the gaseous diffusion plants. When compared with those in the original Line Recorder, the new circuits perform equally as well or better and have the advantages of using no batteries, of utilizing solid state devices almost completely, and of occupying about one-third of the panel space. The design of the circuits and their principal operating features are described. (auth)

19986 (LA-DC-7762) IMPROVED RESOLUTION NEUTRON RADIOGRAPHY. Blanks, B. L.; Garrett, D. A.; Morris, R. A. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 30p. (CONF-670505-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 5th International Conference on Nondestructive Testing, Montreal, Canada.

Experiments in neutron radiography have demonstrated the feasibility of producing radiographs with image resolution comparable to that produced with x or γ radiation. Neutron collimation and imaging experiments are described in relation to the general problem of image unsharpness. Theoretical and experimental analyses of a neutron beam emergent from a simple collimating system are presented. Emphasis is placed on the angular divergence of the primary neutron beam and the resultant intensity pattern produced in the image plane. The theoretical analysis is shown to be basically correct for simple collimators and, in a qualitative manner, is applied to the more complex collimating systems employed in production neutron radiography. The results of production applications of neutron radiography are described and include the detection of an O-ring in a nitrogen valve, the inspection of metallic-encapsulated high explosive components, and the detection of the boundary between different isotopic uranium compounds. (auth)

19987 (LNF-65/31) INTENSIFICATORE DI IMMAGINE A TRE STADI A FOCALIZZAZIONE MAGNETICA. (Three-Stage Image Intensifier with Magnetic Focusing. Note No. 223. Habel, R.; Letardi, T.; Marangoni, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Sept. 10, 1965. 14p. (In Italian). Dep. mn.

An image intensifier is described which is characterized by an ability to make photographable images, with normal emulsions, that would scarcely appear at the threshold of photographability with advanced techniques. The principles of operation, design, and construction are discussed. Its characteristics were experimentally determined. The tube developed serves as a preliminary study for the development of an intensifier capable of revealing a single photoelectron. (J.S.R.)

19988 (MATT-503) USE OF THE MULTICHANNEL TAPE RECORDER AS AN ENGINEERING TOOL. Simon, Ellis D. (Princeton Univ., N. J. Plasma Physics Lab.). Dec. 1966. Contract AT(30-1)-1238. 15p. (CONF-661016-32). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

In the past decade industry has developed high performance analog and incremental tape recorders for data acquisition. In addition to routine data handling, there are at least two applications in the plasma physics field where these recorders can produce substantial savings in both engineering manpower and equipment downtime. In initial tests of high energy systems at the Plasma Physics Laboratory, on-line use of an analog recorder makes possible continuous surveillance of fourteen different parameters. Those parameters in the range of dc to 600 kHz may be retrieved with oscilloscope accuracy. This widespread, long term surveillance has provided information which has enabled us to reduce trouble shooting time by days in some cases. Intermittent faults in operating systems also cause machine down time and use large numbers of man hours since they are so difficult to observe. An analog recorder operating in a continuous loop mode can record and preserve data on faults of this type. The Plasma Physics Laboratory is presently developing a comprehensive tape system for testing and trouble shooting. The system will consist of two fourteen-channel analog recorders with loop capabilities, time code generating and translating equipment, a multiple scope display, a strip chart recorder, and a thirty-channel incremental recorder. This will provide a fourteen-channel data handling system with great flexibility which is computer accessible. (auth)

19989 (ORNL-TM-1726) STUDY OF THE THEORETICAL AND PRACTICAL LIMITATIONS OF LOW-CURRENT AMPLIFICATION BY TRANSISTORIZED CURRENT-FEEDBACK DC ELECTROMETERS. Kennedy, Eldredge Johnson (Oak Ridge National Lab., Tenn.). Apr. 1967. Contract W-7405-eng-26. 325p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

The objectives of this study were to develop the theoretical equations for a transistorized current-feedback dc electrometer, so that the basic sensitivity limitations could be established; and to utilize these equations for the design and evaluation of electrometers containing bipolar transistors, junction field-effect transistors, and metal-oxide-semiconductor (MOS) field-effect transistors in the input stage. Equations for the input impedance, output impedance, transfer function, output offset-voltage, drift characteristics, and noise power spectral density were derived for each type of electrometer. An extension of the theory for bipolar transistors operating at very-low emitter currents (in the 10^{-10} ampere range) was made, and experimentally verified. An experimental determination of the static characteristics of junction and MOS field-effect transistors was presented. The theoretical equations for gate leakage current and zero temperature-coefficient drain current were developed, and experimentally confirmed, for the MOS field-effect transistor. The requirements for the ideal input-stage MOS transistor, operating in a current-feedback dc electrometer, were stated. Three practical electrometers were built, and experimentally correlated with the design theory. The agreement between the theoretical sensitivity equations and the experimental results was generally good. The minimum amplifiable dc input current for each electrometer was as follows: for the bipolar transistor electrometer, $I_{in} \approx 8 \times 10^{-14}$ ampere; for the junction field-effect transistor electrometer, $I_{in} \approx 4 \times 10^{-15}$ ampere; and for the MOS field-effect transistor electrometer, $I_{in} \approx 5 \times 10^{-16}$ ampere. Practical electrometer circuits and, in addition, several useful designs for dc amplifier stages are presented. Systems are also presented for measuring the noise power spectral density and the base resistance of a bipolar transistor. A circuit design of a battery-regulated power supply for the electrometers is also included. (auth)

19990 (PPAD-616-D) APPLICATION OF SATURABLE REACTORS TO NON-REGULATED D.C. POWER SUPPLIES FEEDING PULSATING LOADS. Mrozowski, T.; Steinitz, S. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Mar. 20, 1967. Contract AT(30-1)-2137. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The use of saturable reactors in nonregulated dc power supplies is discussed. It was found that the use of these reactors on the ac side gives very satisfactory performance in limiting short circuit currents, minimizing line voltage fluctuations, and protecting power supply components. The saturable reactors are used as line and follow through current limiters and not as current regulators. (B.G.D.)

19991 (RISO-M-448) BERETNING OM ARBEJDET I ELEKTRONIKAFDELINGEN I TIDEN 1 APRIL TIL 30 JUNI 1966. (Quarterly Report of the Electronics Department for the Period April 1-June 30, 1966). (Danish Atomic Energy Commission, Risoe. Research Establishment). Sept. 1966. 27p. (In Danish and English). (R-6-66). Dep. mn.

A progress report is presented on instrumentation. Topics discussed are data processing techniques, industrial instrumentation, reliability studies, analog techniques, and isotope techniques. (J.S.R.)

19992 (SC-DR-66-2689) PHOTOMULTIPLIER DETECTORS FOR LASER INTERFEROMETRY. Hollenbach, R. E. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A device is required that will detect the light fringes from a Michelson interferometer when one of the two mirrors is moving rapidly. Two multiplier phototubes were tested for this application. One is useful for mirror velocities up to 100 ft/sec, while the other is usable for velocities up to 500 ft/sec. Suggested circuits for operating both tubes are presented. (auth)

19993 (SC-TM-66-567) BALLISTIC PENDULUM SHOCK CALIBRATOR. Woodward, M. H. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1966. Contract AT(29-1)-789. 49p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The ballistic pendulum has been used as a standard facility for the calibration of shock transducers. This facility has been redesigned and is now in use. The purpose of the redesign is discussed, and drawings, sketches, photographs, and assembly instructions necessary for the reproduction of this calibration facility are shown. (auth)

19994 (UCRL-14545) EXPONENTIAL GENERATOR FOR STANDARDIZATION OF APPARATUS USED IN PULSED NEUTRON MEASUREMENTS. Aslin, H. K.; Pierce, G. A. (Califor-

nia Univ., Livermore. Lawrence Radiation Lab.). Nov. 22, 1965. Contract W-7405-eng-48. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An electronic instrument which produces exponentially decaying count-rates has been constructed. This instrument is used as a standard for determining the accuracy and repeatability of a digital analyzer and computer program. The digital analyzer and computer program are used in the measurement of prompt neutron decay constants by means of the pulsed neutron technique. (auth)

19995 (UCRL-14559) 200-MEGACYCLE SYNCHRONOUS-START GATED OSCILLATOR. Jenson, Norman C.; McGee, Max E. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 19, 1965. Contract W-7405-eng-48. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The design and operation of a 200-Mc synchronous-start gated oscillator with a transition time of 5 nsec per stage are discussed. (B.G.D.)

19996 (UCRL-14650-T) A LOW-POWERED MAGNETIC HALL PROBE FOR SPACE APPLICATIONS. McQuaid, J. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 10, 1966. Contract W-7405-eng-48. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A magnetic Hall probe was developed for use in a spectrometer system aboard NASA's OGO-E Satellite. The probe is to monitor the flux in each of the two spectrometer magnets. This flux is in the order of 800–900 Gauss for the small magnet and 2500–2700 Gauss for the large magnet. When measuring long term variations in the magnetic field it is not necessary to continuously monitor the flux; therefore the Hall generator in this system operates on current pulses of short duration. The pulsed current mode of operation affords high efficiency and low power consumption. In the system described, the Hall generator is placed in the magnetic field and driven by a pulse generator. The resulting Hall voltage (which is proportional to the magnetic flux) is amplified and fed to a pulse stretcher. The stretcher circuit preserves the pulse amplitude for a time which is suitable for accurate readout. (auth)

19997 (ANL-Trans-440) A CRYOSTAT OPERATING ON THE HEAT OF TRANSITION OF ^{3}He FROM AN ^{3}He-RICH SOLUTION TO AN ^{4}He-RICH SOLUTION. Peshkov, V. P. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Zh. Eksp. Teor. Fiz., 51: 1821-8(1966). 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Calculations referring to an installation operating on the heat of transfer of ^{3}He from one liquid phase of helium to another are presented. It is shown that at temperatures of the order of millidegrees the cold productivity is proportional to the heat of transition $q = 100\ T^2$ [J/M]. When the ^{3}He circulation rate is 1.6×10^{-4} M/sec a temperature of 0.001°K can be attained and 5 ergs/min can be absorbed at this temperature. (auth)

19998 (UCRL-Trans-10090) DESCRIPTION OF APPARATUS FOR THE STUDY OF POINT DEFECTS BY X-RAY SCATTER. Levelut, A. M. Translated by T. O. Lazar (Univ. of California Lawrence Radiation Lab., Livermore), from J. Phys. (Paris), 24: 560-4(1963). 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

An apparatus for observing weak x-ray scattering near the incident beam was constructed. Very good sensitivity is achieved by a point collimation system and cylindrical symmetry. It is thus possible to study the distribution of point defects in crystals, provided their concentration is sufficiently high. (auth)

19999 (UCRL-Trans-10092) APPARATUS ENABLING THE STUDY OF POINT DEFECTS IN SOLIDS BY X-RAY SCATTERING. Levelut, A.-M.; Lambert, M.; Guinier, A. Translated by T. O. Lazar (Univ. of California Lawrence Radiation Lab., Livermore), from Compt. Rend., 255: 319-21(1962). 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

The sensitivity of the apparatus is achieved by increasing the solid angle over which the scattered energy is collected. Some experiments on alloys demonstrate the possibilities of the apparatus. (auth)

20000 AN ANEMOMETRIC ISOKINETIC SAMPLING PROBE FOR AEROSOLS. Boothroyd, R. G. (Univ. of Birmingham, Eng.). J. Sci. Instrum., 44: 249-53(Apr. 1967).

A new type of probe for the isokinetic sampling of aerosols is described. The instrument comprises, essentially, a hot wire anemometer together with potentiometer and a reversible sampling probe. Examples of test results for a particular instrument are given. The sampling can be easily and quickly adjusted to isokinetic flow with less than a 2% error in the sampling velocity. The necessary techniques and precautions for constructing and operating an instrument of arbitrary configuration are outlined. (auth)

20001 PHOTOIONIZATION SOURCES FOR MASS SPECTROMETERS. Beynon, J. H. (Imperial Chemical Industries Ltd., Blackley, Eng.); Fontaine, A. E.; Turner, D. W.; Williams, A. E. J. Sci. Instrum., 44: 283-4(Apr. 1967).

The value of a source of high energy photons (10–25 eV) to produce ions for analysis in a mass spectrometer lies in the study of compounds that are unstable and suffer degradation in the conventional hot electron impact ion source. All-glass, windowless photon sources, utilizing direct current discharges in various gases at about 1 torr, were designed for use on the line of sight inlet port on the standard MS 9 source. The practical limit on the photon intensities available is the wattage dissipation that is possible in the discharge lamps. By using a helium discharge in a 1 mm diameter quartz capillary, uncooled in vacuum, it is possible to expend 10 w cm^{-1} for long periods. Typical intensities of photoion beams available from continuous helium discharges in these lamps are ten to twenty times weaker than those resulting from electron impact by a 10 μA electron beam. By using hydrogen or neon discharges considerably greater photoion intensities are obtained, though at lower energy. (auth)

20002 RADIAL AND AXIAL PHASE DISTRIBUTION OF THE POTENTIAL IN AN AC ARC. Korshakevich, I. I. (Inst. of Physics, Krasnoyarsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 91-3(1966). (In Russian).

The free-probe method, widely used for studying dc arcs, was used for potential distribution measurements in ac arcs. The positive half period of a vertical ac arc, burning in air between copper electrodes, at a discharge-current amplitude of 6 to 35 amp. was used for the measurements. The 0.1-mm diameter platinum wire probe was rotated horizontally, cutting the discharge at a rate of about 20 amp./sec. at a certain phase at various distances from the cathode, carrying out measurements at every 0.5 mm of the distance. A plot of the changes in the electrode potential drop as a function of the discharge phase at 7 and 16 amp. showed that the cathode drop at the end of the discharge is increased by a factor of 2, while the anode drop is a function of the burning potential of the discharge. The overall radial potential distribution between was found to be quite complex. In the internal portions of the discharge column, bounded by a surface of the same conductivity, the radial potential distribution was found to vary from point to point, depending on the distance from the cathode and the phase of the discharge phase. The potential distribution in the external region was found to exhibit a normal distribution. (TTT)

20003 ASSOCIATIVE ANALYSIS IN A SMALL COMPUTER. Hooton, I. N.; Best, G. C. (Atomic Energy Research Establishment, Harwell, Eng.). pp 341-51 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

In many nuclear physics experiments the experimental data field is large while the number of active descriptors is relatively small. Associative storage has been suggested as a means of processing this type of data but is more expensive per descriptor processed than conventional analysis. Costs may be reduced by taking advantage of the fact that in many experiments data occur in groups of channels. The zone selection technique is adopted. The data field is arbitrarily divided into zones of adjacent channels and it is then only necessary to store the addresses of active zones in the associative mode, the individual channels within the zone being defined conventionally. The overall system is then equivalent to conventional analysis with digital windows automatically set by the data in the active regions. A 4096-word twelve-bit PDP 8 was programmed to give associative analysis of 128 zones of 16 channels, 2048 channels total, from a field of 2^{20} channels. A small input buffer gives a pair resolution of 10 μsec while the mean input data rate is more than 10,000 descriptors per second. Continuous map and isometric displays are incorporated, and both display and data collection may be confined to selected areas of the data field. (auth)

20004 PROBLEMS CONNECTED WITH HIGH RATES IN PULSE COUNTING SYSTEMS. Kandiah, K. (Atomic Energy Research Establishment, Harwell, Eng.). pp 420-9 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The energy resolution which can be obtained with pulse counts at low mean rates is limited either by noise in amplifiers or statistical fluctuations of the charge generated in the radiation detector. At a high counting rate the resolution deteriorates further by an amount depending on the duration of the pulse of charge from the detector, the method of pulse shaping used in the particular sys-

tem, and imperfections in the analogue-to-digital converter. The magnitudes of these effects in typical systems, and the methods used to minimize the loss of resolution at high rates are discussed. Pulse shaping with delay lines, or with more elaborate active shaping circuits, enables the counting system to cope with much higher rates than is possible with simple CR shaping, at the expense of greater complexity. A new pulse analysing system is described, using direct coupled amplifiers and active pulse shaping by means of feedback to photodiodes at the input of the amplifier. The merits of such a system at high rates are discussed. (auth)

20005 TIME-SHARED ON-LINE COMPUTER-BASED NUCLEAR DATA ACQUISITION SYSTEM. Page, J. G.; Collins, R. J. (Univ. of Texas, Austin). pp 358-64 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

In a nuclear laboratory possessing facilities for carrying out simultaneous independent experiments the ability to time-share a data acquisition system has significant advantages. Such a system, now in operation at The University of Texas (Accelerator Laboratory), is described with special reference to the interfacing and programs necessary for this kind of operation. The computer has a short instruction list and is relatively fast. It is equipped with an automatic priority program interrupt system and a data interrupt facility which includes modifications intended to simplify data acquisition and reduction. Connected on line are two 400-channel pulse-height analysers and three (slow) 1024-channel analogue-to-digital converters for use in a variety of single- and multi-parameter experiments, and a fast triple analogue-to-digital converter system is under construction. Included are remote-control panels and several multiplexers which handle the data and program requests and allow simultaneous operation of all on-line equipment. A time-sharing program handles all on-line program requests for raw data outputs and, simultaneously with data acquisition, allows the operation of programs written either in FORTRAN or source language, or the preparation of new programs. (auth)

20006 COMPUTER PROCESSING OF EXPERIMENTAL NUCLEAR DATA FROM THE HARWELL NEUTRON PROJECT. Schomberg, M. G.; Avery, M. R.; Bowey, E. M.; James, G. D.; McConnell, D. B.; Moxon, M. C.; Pattenden, N. J.; Patrick, B. H.; Sowerby, M. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 370-5 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The primary function of the Harwell Neutron Project is to make measurements of neutron cross sections of materials as a function of neutron energy. A 45 MeV electron accelerator is used as a pulsed neutron source and the time-of-flight method is used for energy selection; up to ten time-of-flight spectrometers can operate simultaneously. Typically, about 5×10^7 neutron events are recorded per day, and the project runs continuously. The storage, processing and analysis of the data are all carried out by computer. Individual events from each spectrometer are digitized and written on 1 in. wide magnetic tape, which is subsequently read into a Digital Equipment Corporation PDP-4 computer. This sums the events in each of 16,384 memory locations corresponding to time channels. They may then be observed on a large cathode ray tube display, operated on by computer programs or written on to IBM-compatible magnetic tape for reading into the United Kingdom Atomic Energy Authority's Aldermaston IBM STRETCH computer, for more complicated processing. One of the most important features of the system is that of having a small computer, under the control of the experimenter, which can operate on the data at a fairly early stage after their collection. This reduces the possibility, always present when large quantities of data are being collected automatically, that faults which develop in the apparatus are not detected until long after the data are collected. (auth)

20007 DIGITAL GATE FOR A TWO PARAMETER MULTICHANNEL ANALYZER. Jaklevic, J. M.; Chagnon, P. R. (Univ. of Notre Dame, Ind.). Nucl. Instrum. Methods, 51: 175-7(1967).

The design and construction of a digital gate and four quadrant routing circuit for use with a two parameter multichannel analyzer is described. The application of this device to coincidence measurements employing Ge(Li) detectors is discussed. (auth)

20008 RETARDATION EFFECTS DUE TO THE LOCALIZED APPLICATION OF ELECTRIC FIELDS ON THE PHOTOCATHODE OF A PHOTOMULTIPLIER. Charpak, G. (CERN, Geneva). Nucl. Instrum. Methods, 51: 125-8(1967).

It is shown that by applying electrical voltages of some hundreds of volts to transparent conductors placed against the photocathode of a photomultiplier, on the external side, two effects are observed: 1. the intensity of the electron emission can be modulated locally; 2. the photoelectrons can be slowed down and very long delays can be obtained for electrons emitted by a localized part of the photocathode. (auth)

20009 EFFICIENCY OF UTILIZATION OF MEMORY SPACE IN CONTENT ADDRESSABLE SYSTEMS. Hoffman, Z. (Leicester Regional College of Tech., Eng.). Nucl. Instrum. Methods, 51: 136-40(1967).

In multiparameter experiments content addressable systems offer a much better utilization of memory space than conventional multiparameter analysers. Also, in many cases the number of channels in a content addressable system is not sufficient. Input data must be selected to collect a sample of descriptors. The efficiency of utilization of memory space when collection of information is based on the principle "first come, first served" is studied. The method of zone selection is analysed and a numerical example is given. A new method with a more efficient collection of useful information is proposed and described. Examples with a simplified frequency distribution of input descriptors both for one and for two parameter experiments are evaluated. Comparison between the principle "first come, first served" and the new method is given. As an illustration the new method might give 90% of effect-descriptors in a sample of information in comparison with 50% for the old method. (auth)

20010 METHOD OF PAIR-SELECTION IN CONTENT ADDRESSABLE SYSTEMS. Hoffman, Z. (Leicester Regional College of Tech., Eng.). Nucl. Instrum. Methods, 51: 141-52 (1967).

An extension is given of the method of pair-selection previously described. The theory of this method for general and continuous distributions of input information is given and the theory of the automatic digital window is introduced. Several examples with a rectangular distribution of input information are solved. The results evaluated for an input distribution in the form of two peaks with different width and height are presented. Two simplified cases with a triangular distribution and a distribution represented by a normal curve and constant background are solved. As a result three practical applications of pair-selection are proposed. (auth)

20011 IMPROVED METHOD OF CHECKING THE LINEARITY OF A PHOTODETECTOR. Aramu, F.; Rucci, A. (Univ., Cagliari, Italy). Nucl. Instrum. Methods, 51: 153-5(1967).

A very simple device is proposed to check the linearity of response of a photodetector; it is substantially easier to use and more accurate than the conventional technique. The results obtained using photomultipliers are presented and a comparison is made with the theoretical previsions. Evidence is displayed of the usefulness of the proposed method. (auth)

20012 SIMPLE METHOD TO PREDICT THE RESOLUTION OF A FOCUSED COLLIMATOR AT ANY DEPTH. Vetter, H. G. (Massachusetts General Hospital, Boston). Int. J. Appl. Radiat. Isotop., 18: 237-42(Apr. 1967).

A practical method to evaluate the resolution of a focused collimator at any depth is suggested. It operates by decomposing the imaging process of the collimator into two successive steps, one involving the single tube spread function alone and the other the parallax effect introduced by the multiplicity of holes. The method is not rigorous, but very rapid, and gives results in reasonable agreement with direct measurements. It also permits immediate optimization by visual inspection between hole size and overall collimator aperture. (auth)

20013 KLYSTRONS FOR THE STANFORD LINEAR ACCELERATOR (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE-1500).

124 drawings.

Klystron tubes used to supply the power to accelerate electrons in the Stanford Linear Accelerator are described. The klystrons produce a minimum of 21 MW peak and 20 kW average at 250 kV beam voltage when focused in permanent magnets. The output windows of the klystrons are also described. These windows are coated with Ti which is applied by sputtering in an Ar atmosphere with limited amounts of O added. Coating thickness limits of 80 to 150 Å are used. (For details see TID-4100 Suppl. 39.) (F.S.)

20014 METHOD AND APPARATUS FOR DETECTING IMMINENT BOILING. Maropis, Nicholas. British Patent 1,064,662. Apr. 5, 1967. Priority date May 27, 1963, United States.

A method and equipment are described for detecting imminent boiling and cavitation. The method may be used in an operating pressurized water reactor. The apparatus comprises a vibratory probe which produces controlled vibratory motion within the liquid, noise detection means for detecting cavitation noise produced in the liquid, means for measuring power transmitted to the probe from a transducer, and a means for comparing the power trans-

mitted to the probe needed to cause cavitation with a standard dependent upon the boiling point of the liquid. (F.S.)

20015 BIBLIOGRAPHY ON FLAME SPECTROSCOPY. ANALYTICAL APPLICATIONS 1800 TO 1966. Mavrodineanu, R. (comp.). National Bureau of Standards Miscellaneous Publication 281. Washington, D. C., National Bureau of Standards, 1967. 162p. $2.00 GPO.

Flame spectroscopy, especially in its analytical applications, continues to be an active field of study. Its literature is growing steadily, and the use of flame photometry in many specialized applications calls for a comprehensive indexed bibliography. This collection consists of 5,113 references to works on flame spectroscopy, selected with emphasis toward analytical measurements. It covers the period from 1800 to 1966. Subject indexes, keyed by number to the references cited, precede most of the sections. (auth)

Radiation Effects on Instruments and Instrument Components

20016 (AD-648642) SILICON DIODE FAST-NEUTRON DOSIMETER. PHASE IV. DETERMINATION OF THE ENERGY DEPENDENCE OF THE DAMAGE CONSTANT. Speers, R. R. (Phylatron Corp., Columbus, Ohio). Jan. 1967. Contract DA-18-035-AMC-101(A). 43p. (NDL-TR-83(4)). CFSTI $3.00 cy, $0.65 mn.

Monoenergetic neutron irradiations of 50-mil-base-width silicon diodes were performed to determine the neutron energy dependence of the electrical parameters of the p-i-n diodes. The $T(p,n)^3He$, $D(d,n)^3He$ and $T(d,n)^4He$ reactions and the Ohio State University 5.5-MeV Van de Graaff were used to produce neutrons having energies from 0.36 to 22.5 MeV. The diodes were fabricated from high lifetime, 600 ohm-cm, p-type material. The lifetime of the material in the base of the diode was typically 60 μs. The energy dependence of the neutron bombardment degradation of two diode parameters was investigated. The parameters studied were damage coefficient for storage time and forward-voltage sensitivity at constant current. Neutron fluences in the range of 10^9 to 2×10^{10} n cm^{-2} were employed for the irradiations. The results showed that the neutron energy dependences of the two parameters were identical and varied approximately as the square root of neutron energy for neutron energies from 0.36 to 4.77 MeV. For neutron energies above 4.77 MeV the experimental results do not follow a systematic trend. (auth)

20017 (LMSC-6-76-66-8) OBSERVATIONS OF NONLINEAR TRANSIENT RADIATION EFFECTS IN SEMICONDUCTORS. Smith, E. A.; Schallau, J. W.; Andrew, A. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). June 1966. 24p.

Primary photocurrent is a fundamental parameter for the prediction of device and circuit response to ionizing radiation. When the radiation intensity is greater than 10^8 RAD/sec some devices begin to exhibit nonlinear response to the radiation, and previously held assumptions are no longer accurate. In addition to variations between devices (geometries, doping profiles, etc.), the nonlinear response has been shown to be a function of dose rate and external bias voltage. Data are presented illustrating the response of various transistors covering the dose rate range from 10^7 to 3×10^{10} RAD/sec. The results indicated that many of the simplifying assumptions regarding primary photocurrents must be modified at dose rates above 10^8 RAD/sec. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 19548, 20241, 20304, 20314, 20347, and 20409.

20018 (AECD-AG-9) FAO/I.A.E.A.-P.A.E.C. CO-ORDINATED PROGRAMME ON THE APPLICATION OF ISOTOPES AND RADIATION IN RICE CULTIVATION, 1964-65 (ON TRANSPLANTED AMAN PADDY: WINTER RICE). 1. TO DETERMINE THE EFFICIENCY OF FERTILIZER NITROGEN APPLIED TO LOW LAND RICE AS AFFECTED BY PLACEMENT AND THE INTERACTION WITH PHOSPHORUS PLACEMENT. 2. TO DETERMINE THE EFFICIENCY OF FERTILIZER PHOSPHORUS AS AFFECTED BY PLACEMENT AND THE INTERACTION WITH NITROGEN PLACEMENT. Khan, Abdul Baten; Bhuiyan, Sarwarjan; Habibullah, A. K. M.; Chowdhury, Saiful Islam; Alam, S. Manzoor (Atomic Energy Centre, Dacca (Pakistan)). Dec. 1965. 28p. Dep. mn.

From 4th Planning Meeting of International Atomic Energy Agency, Bangkok, Thailand.

Results are summarized from studies on the effects of P and N in fertilizers on plant development and yield of rice, in which ^{32}P and ^{15}N were used as tracers. Data are included on the effects of surface application or deep placement of fertilizer and the interaction between P and N in fertilizers. It is pointed out that the successful application of fertilizer is very important in a region of high rainfall (70 to 80 inches during a six-month period.) (C.H.)

20019 (ARCRL-16, pp 27-69) EXPERIMENTAL STUDIES. (Agricultural Research Council, Wantage (England). Radiobiological Lab.).

Progress is reported in the following studies: quantitative studies on the barley root systems; effect of microorganisms on the uptake and distribution of phosphate in intact plants; transport of ions into the xylem sap of plant roots; the entry and loss of ions in small sections of intact root systems; the effect of variations in the ratio of strontium to calcium supplied to plants on the relative uptake of these ions from solution; comparative distribution of the alkaline earth elements in cereal plants; distribution in potatoes of strontium and calcium absorbed from different depths in the soil; measurement of isotopically exchangeable potassium in the soil; the effect of electrolytes on the self-diffusion of strontium in soil; relative movement of cesium-137 and strontium-89 through soils; absorption of calcium and phosphate by barley, kale, and ryegrass from different depths in soil; the relative ability of lucerne and ryegrass to absorb phosphate and calcium from different depths in soils of contrasting phosphate status; the influence of the ammonium ion on the absorption of phosphate and other ions by maize; the effect of gamma irradiation on the growth and yield of crop plants; prediction of future levels of long-lived fission products in milk and the average mixed diet. (H.L.W.)

20020 (BNWL-SA-1032) MODEL FOR THE ACTION OF RADIATION ON SIMPLE BIOLOGICAL SYSTEMS. Roesch, W. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 5, 1967. Contract AT(45-1)-1830. 14p. (CONF-670305-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Biological Interpretation of Dose from Acceleration Produced Radiation, Berkeley, Calif.

The hit hypothesis in radiobiology is that deposition of energy concentrated along the tracks of charged particles in the irradiated material, rather than spread uniformly throughout the medium, is responsible for the potency of the radiation and for the shape of the observed dose-effect curves. Most investigators accept the hypothesis, but past mathematical elaborations of it have been only partially successful in explaining observed phenomena. In particular, dose-rate and fractionation effects are difficult to explain. Also, the fairly general tendency of survival curves to be asymptotically exponential has been explained as due to the presence in each individual of more than one site that must be destroyed by the radiation. Current biological evidence is against the presence of such multiple sites. This paper is concerned with explaining these phenomena by developing a different mathematical elaboration of the hypothesis. (auth)

20021 (CMN-Pub-2/66) APLICACOES DOS RADIOISOTOPOS EM PESQUISAS BIOLOGICAS. (Use of Radioisotopes in Biological Studies). Rapp de Eston, Veronica; Eston de Easton, Tede; Domingos do Amaral, Ary; Hundt, Gerhardt Fritz (Sao Paulo Univ. (Brazil). Centro de Medicina Nuclear). 1966. 144p. (In Portuguese). DTIE.

The text for a course in the application of radioisotopes in biological studies is presented. The first section is concerned with the preparation, control, and determination of various labeled compounds. In the second section the use of labeled compounds in biological studies is illustrated. The topics discussed include autoradiographic technique, uptake, metabolism, and excretion of ^{131}I, synthesis of iodide hormones, effect of ionizing radiation on cells, absorption of nutrients by plants, mechanism of photosynthesis, and fixation of CO_2 by plants. (J.S.R.)

20022 (CONF-660422-4) DISTRIBUTION OF COLLOIDAL THORIUM DIOXIDE IN MOUSE LIVER AFTER INTRAVENOUS INJECTION. Hampton, J. C.; Rosario, B. (Northwestern Univ., Chicago, Ill. Dept. of Anatomy). [nd]. Contract AT(11-1)-1244. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York.

The distribution in mouse liver of ThO_2 at 10 minutes and 1 month after intravenous and intrasplenic injection was not significantly different for doses of 0.1, 0.25 and 0.5 ml. At 10 minutes after injection, particles were still present extracellularly in sinusoidal lumens, in the space of Disse and in spaces between hepatic parenchymal cells. Many particles were bound to the plasma membranes of and within the cytoplasm of Kupffer cells. The particles did not appear to be bound to the plasma membrane of parenchymal cells but were taken up by them through vesicle formation both at the cell surface bordering upon that space of Disse and at the surface bordering intercellular spaces. At 1 month after injection sinusoids were occluded by large Kupffer cells packed with particles. The space of Disse surrounding occluded sinusoids was obliterated and often contained bundles of collagen. Dense aggregates of particles were found in parenchymal cells and occasionally in bile canaliculi. On rare occasions loose aggregates of particles were found in parenchymal cell nuclei. (auth)

20023 (COO-1156-17) EFFECT OF AGE ON RADIOACTIVE AND STABLE STRONTIUM ACCUMULATION IN MULE DEER BONE. Farris, G. C.; Whicker, F. W.; Dahl, A. H. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). May 1966. Contract AT(11-1)-1156. 21p. (CONF-660561-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Symposium on Some Aspects of Strontium Metabolism, Chapelcross, Annan, Scotland.

Metacarpal and femur bones of Colorado mule deer (Odocoileus hemionus hemionus) of various age classes were collected in order to study radioactive and stable strontium distribution within a deer herd. Average strontium-90 and stable strontium concentrations in bone of six age classes were significantly different. The highest levels of radioactive strontium were in the younger age classes and stable strontium concentrations were larger in the older age groups. Considerable variation in the radioactive and stable strontium content of metacarpals was observed within age classes. No significant difference in radioactive or stable strontium content was observed between the sexes of deer younger than 17 months. Sex was not compared in older age classes because of limited sample size. Estimates of strontium turnover rates indicated values of about 19 percent per year for juvenile and 6 percent per year for adult deer. (auth)

20024 (COO-1495-2) TECHNICAL PROGRESS REPORT [ON MOVEMENT OF STRONTIUM THROUGH THE SOIL TO THE PLANT ROOT], JUNE 1, 1966-MAY 31, 1967. (Purdue Univ., Lafayette, Ind.). Feb. 10, 1967. Contract AT(11-1)-1495. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The mechanisms of root interception, mass-flow, and diffusion in supplying strontium and calcium to the root surface were studied. Lettuce, wheat, tomatoes, and soybeans were grown in four kinds of soil in a controlled climate chamber. Root interception and mass-flow supplied more strontium and calcium to the root than was absorbed by the root. Experiments on the effect of plant species and relative humidity on the average plant weight, transpiration ratio, root volume and soil volume occupied by roots, and experiments on the effect of plant species on the relation of calcium and strontium to the calculated supply by root interception and mass-flow were conducted. Results are tabulated. Graphs are presented to show the effect of plant species on the relation between strontium supply and strontium uptake and the relation between calcium supply and calcium uptake. Experiments on the effect of soil properties on the distribution coefficient of calcium and strontium between the solid and liquid phase of the soil were conducted. Graphs are presented to show results. (H.L.W.)

20025 (COO-1603-1) THE EFFECTS OF TRITIUM DECAY ON DNA. Progress Report, June 1, 1966-December 31, 1966. Rachmeler, Martin (Northwestern Univ., Chicago. Medical School). Contract AT(11-1)-1603. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Research is reported on the effects of tritium decay in cells on various parameters such as viability, enzyme-forming ability, and mutagenesis. Emphasis was placed on the effects of tritium on the physical integrity of the DNA molecule. Results suggested a strain difference in regard to sensitivity to tritium decay. The viability of E. coli 15T⁻, for example, seemed to be more sensitive to tritium decay than that of K12SH-28. The possibility that this difference is related to the efficiency of the DNA repair mechanism is under investigation. Studies on the physical integrity of the DNA molecule, both in vitro and in vivo, indicate that the DNA molecule is degraded by tritium decays into lighter, heterogeneous fractions. Structure of these fractions is being examined by hyerchromicity. Methods for examining enzyme-forming ability and mutagenesis are described. (H.G.D.)

20026 (EUR-2765.f) EFFET RESTAURATEUR DES ACIDES NUCLEIQUES APRES IRRADIATION. Rapport Annuel. (Effects of Nucleic Acids on the Restoration of Irradiated Mammal Cells. Annual Report). (Institut Gustave Roussy, Villejuif (France). Jan. 14, 1966. 16p. (In French). Dep. mn.

In an attempt to study the radiorecovery effect of desoxyribonucleic acid (DNA) on cultured mammal cells, tests were performed to determine whether the acid penetrates the cells under experimental conditions. The cell used (NCTC clone 2472) was obtained from male C3H mouse fibroblasts and was selected for its stability and because radiobiological studies could be carried out with it (in particular, survival curves). The tritiated DNA used was extracted from a strain of Escherichia coli 15 T⁻ by the phenol method. After two hours contact with the radioactive DNA, the cells were lysed and the cellular and exogenous DNA separated by density gradient in cesium chloride. Measurements of the radioactivity and DNA content of each fraction of the gradient shows that the exogenous DNA penetrates the cells, penetration is proportional to the quantity of DNA in contact with the cells, and that the hypothesis that the tracer is re-used by the cells can be discounted, since the radioactivity is localized in the gradients in a very narrow strip of the DNA peak. (auth)

20027 (EUR-3254.e) EFFECTS OF ACUTE AND CHRONIC TERPHENYLS AND METHYLNAPHTHALENES ADMINISTRATION ON HEPATIC PENTOBARBITAL METABOLISM IN THE RAT. Scoppa, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 16p. Dep. mn.

The aromatic hydrocarbons examined and their mixtures, except the para isomer of terphenyl, interfere at high doses with the metabolism of pentobarbital. A single oral dose causes a biphasic response: the rate of pentobarbital metabolism is reduced in the first hours after the intake of hydrocarbon, while after longer time intervals, up to five days, it is strongly accelerated. Chronic administration of terphenyls results in a moderate increase of pentobarbital metabolism. Simultaneous treatment of the animals with ethionine abolishes the increased rate of pentobarbital metabolism produced by the hydrocarbons. (auth)

20028 (ORO-3329-2) THE EFFECT OF RADIATION ON MUCOSAL PHOSPHOLIPASE ACTIVITY. Progress Report. Bernheim, Frederick; Ottolenghi, Athos (Duke Univ., Durham, N. C. Dept. of Physiology and Pharmacology). Oct. 1966. Contract AT(40-1)-3329. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effects of whole-body x irradiation on intestinal phospholipases were investigated. Other intestinal enzymes and the phospholipases of spleen and bone marrow were tested for the purpose of comparing recovery rates of different functions and organs. The mucosal content of acid and alkaline phosphatase and leucine aminopeptidase declined in the first days after irradiation and reached a minimum on the fourth day after x irradiation. Recovery was occurring by the sixth day and by the 12th day enzyme activities did not differ from the control. Experiments on phospholipase resulted in a decline in enzyme content of the mucosa by the third day; by the 30th day the activity returned to normal. Biochemical changes in the phospholipases were studied by means of experiments utilizing variations of radiation dose and time after exposure. The relation between corticosteroid action and phospholipase content of the intestinal mucosa in normal and irradiated animals was studied. The effect of repeated doses of dexamethasone on the phospholipases of the intestine was tested. Nearly complete depletion of the intestinal enzyme occurred. These experiments demonstrated that steroids can mimic the action of x rays on the intestinal phospholipases with regard to both decline and recovery. The response of phospholipases to irradiation in adrenalectomized rats did not differ substantially from that of non-adrenalectomized animals. (H.L.W.)

20029 (STI-PUB-123) RADIOISOTOPES IN THE DETECTION OF PESTICIDE RESIDUES. Panel Proceedings Series. Proceedings of a Panel held in Vienna, 12-15 April 1965. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1966. 120p. (CONF-650457). IAEA: $2.50; S 65,-; 17/8 stg; F Fr 12,30; DM 10,-.

Topics discussed at the panel meeting were as follows: historical background; use of radioisotopes in the detection of residues in meat and milk; the retention of triphenyltin and dieldrin, and its relevance to the toxic effects of multiple dosing; determination of rogor and cidial by the isotope dilution method; metabolism of triazine and 2,4-D herbicides, and problems with their residues in soils and plants; metabolism of chlorinated insecticides; isolation and identification of metabolites of some chlorinated insecticides and their detection by analytical methods; chemical and physical nature of plant cuticles in relation to the deposition and penetration of pesticides; development of double isotope derivative assays for measurement of pesticide residues; potential of neutron activation analysis of pesticides and metabolites; method of activation analysis for mercury in the biosphere and in foods; labeled reagents and substrates in pesticide analysis; advantages and disadvantages of conventional pesticide determination methods; problems in FAO on human and animal intoxication; problems in WHO on pesticide residues; the joint FAO/WHO program on the toxicity of pesticide residues in food; the development and application of pesticide analysis methods. (H.L.W.)

20030 (TID-3585) RADIOISOTOPES IN THE BIOLOGICAL SCIENCES. An Annotated Bibliography of Selected Literature. Ward, Helen L. (comp.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Apr. 1967. 120p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

More than 900 selected references on the use of radioisotopes in biological research are included in this bibliography. These references were selected from the scientific literature published during the period 1958-1963. Author, isotope, and report number indexes are included. (H.L.W.)

20031 (UCB-34P50-3) AN INVESTIGATION INTO THE UTILITY OF RADIATION STERILIZED SOIL AS A MEDIUM FOR GROWTH OF PLANTS AND MICROORGANISMS. Comprehensive Report, January 1, 1959-December 31, 1966. McLaren, A. Douglas (California Univ., Berkeley. Dept. of Soils and Plant Nutrition). Feb. 1, 1967. Contract AT(11-1)-34. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

As an introduction to the study of radiation-sterilized soil as a medium for microbial and plant growth, survival curves for microorganisms were obtained with electron, x rays, and gamma radiation. Survival curves were the same for all types of radiation. Phosphatase activity in electron beam sterilized soil was determined. It was found that phosphatase activity reflected the metabolic activities of living microorganisms and included a relatively stable, extracellular component of enzyme in soil humus. It was found that large molecules of amino acids and proteins could enter plant roots from water cultures. Studies were conducted on the mechanism of entry, the nutritional value, and physiology of the absorbed protein. Tomato plants were grown in radiation sterilized soil and in sterile sand culture in the presence of amino acids. Striking morphological changes occurred in the tops of tomato plants grown on the amino acid mixture in sand. It was found that ^{14}C-labeled proteins were translocated to the foliage of tomato plants if the roots had undergone mechanical injury or if the plants were damaged by wilting. The effect of metabolic inhibitors and physico-chemical properties of the surrounding medium on the rate of lysozyme entry into excised barley roots was studied. The distribution of enzymatic activity between the roots of barley and the rhizoplane organisms was determined for phosphatase, urease, and invertase. The role of rhizoplane organisms in the ability of plants to utilize organic nutrients was studied. (H.L.W.)

20032 (UCLA-12-612) SEMIANNUAL PROGRESS REPORT FOR THE PERIOD ENDING DECEMBER 31, 1966. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Contract AT(04-1)-Gen-12. 105p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate abstracts were prepared on five sections of the report. A list of the articles published during this period is included. (B.H.S.)

For abstracts of individual sections see: 20033-20035, 20112, and 20236.

20033 (UCLA-12-612, pp 1-14) BIOCHEMISTRY. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

In order to determine the origin of the alkenyl ether link in plasmalogens, palmitaldehyde-1-^{14}C was injected intracerebrally into young rats. With the application of gas-liquid chromatographic techniques, the metabolism of palmitaldehyde-1-^{14}C was determined. From the data collected, it was concluded that palmitaldehyde-1-^{14}C was first oxidized to palmitic acid. The palmitic acid was incorporated into the α^1 position of phosphatidyl ethanolamine and was later reduced to give the plasmalogen. Evidence suggested that these changes took place in the phospholipid rather than in the diglyceride precursor. The nature of the long-chain fatty acid mixture of human brain sphingolipids was determined using gas-liquid chromatographic techniques. Fatty acids with chain lengths greater than C_{26} were found to represent a substantial fraction of the total of the brain sphingolipids; the amounts varied from an average of 1% of the total in the cerebrosides to as high as 28% for the unsubstituted fatty acids of cerebroside sulfate. These included the saturated and monounsaturated, odd and even fatty acids from C_{24} through C_{25}. Ceramide and cerebroside sulfate (particularly of gray matter) were found to contain similar quantities of these fatty acids and, in this respect, were quite different from cerebrosides. Chain elongation and 2-hydroxylation pathways that are specific for very long-chain fatty acids (>C_{18}) were found in Candida utilis. The chain-elongation system acted specifically on fatty acids of chain-length C_{20} to C_{24}; no elongation of C_{18} and only trace activity with C_{16} was detected. The products of the elongation enzyme(s) were C_{26} when C_{20}, C_{22}, or C_{24} were substrates; C_{21} and C_{23} substrates produced a mixture of C_{25} and C_{27}. The 2-hydroxylation enzyme converted C_{26} acid, formed in situ by chain-elongation, to 2-hydroxyhexacosanoic acid; the enzyme seemed to be quite specific for the C_{26} chain length. Also, a non-specific system for the oxidative decarboxylation of 2-hydroxy acids was studied in C. utilis. All 2-hydroxy fatty acids tested (C_{18} to C_{26}) containing an even number of carbon atoms were converted, in part, to the unsubstituted acid containing one carbon less than the substrate. An examination of 4 species of Bacilli revealed that they all carried out the cis-5-desaturation reaction to the exclusion of the much more common cis-9-desaturation. Only palmitic and stearic acid were found to serve as substrates. The effects of growth and incubation temperature on the desaturation reaction were also investigated. An abstract of a detailed report on exposure of oleic acid in the absence of air to ^{60}Co γ rays is presented. Results of the study were in agreement with findings in earlier investigations that involved other types of ionizing radiation. Further work on the γ radiolysis of stearic acid was reported to be in progress. Preliminary results on the biosynthesis of wax esters in Lampanyctus ritteri and Sternobrachius leucopsarus clearly established that acetate was incorporated, both in vivo and in vitro, into the acid and the alcohol moieties of the wax esters synthesized in the fish. The techniques and approaches being used to study the changes in lipid metabolism of cultured heart cells, effects of fatty acids on mitochondrial function and beating in rat heart cells, restoration of beating in cultured heart cells by lipid fractions, and the relation of growth to loss of heart cell function are discussed. Preliminary results indicated that the role of lipids in maintaining short-term function in cultured rat heart cells was not due to their capacity to maintain membrane integrity. (B.H.S.)

20034 (UCLA-12-612, pp 15-36) RADIOBIOLOGY. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

Aqueous solutions of thymine dimer saturated with air, nitrogen, or oxygen were γ-irradiated at neutral and acidic pH's. One of the major products formed was the thymine monomer. The G values for dimer destruction to give the monomer were found to be highly dependent upon pH and oxygen concentration: nitrogen saturated, neutral pH 3.17; oxygen saturated, acidic pH 0.22; and air saturated, neutral pH 0.52. A linear decrease in G-monomer formation with Cu^{2+} concentration was observed; with formate ion scavengers, no change or possibly an increase in thymine monomer was observed. Escherichia coli TAU in which the DNA was labeled with 2^{14}C or $^{14}CH_3$ thymine were irradiated. Analysis by chromatography of solutions consisting of tagged whole cells or DNA, γ- or uv-irradiated, frozen or unfrozen, and hydrolyzed in perchloric acid revealed that uv-irradiated DNA or whole cells gave one major product that chromatographed like the thymine dimer and two additional products (not identified). No detectable products of thymine were observed from γ-irradiated cells even when they were irradiated to upwards of 9×10^{23} eV/l in the frozen state. It was concluded that the techniques used were not sensitive enough to detect the small yields of dimer or of other products if they were ever formed. Proposals for the study of reaction rates of hydrated electrons with many compounds by pulse radiolysis techniques are presented. Photoreactivation reactions in E. coli was the method chosen for pursuing this research. Degradation of aqueous oxygenated solutions of the polynucleotides of adenine, uracil, cytosine, and hypoxanthine induced by γ radiation were examined by chemical methods. Results from measurements of the amount of base destroyed by irradiation of random coil, double or mixed helix structures, and mononucleotides of the base moieties are presented. The mechanism of γ radiation induced degradation of cysteine in aqueous oxygenated solutions was investigated using ^{14}C-tagged cysteine. Cystine was the only radiation product formed. Measurements of oxygen consumption, peroxide formation, and cysteine destruction in the presence of radical scavengers established the fact that OH and O_2^- radicals were both initiators of the chain reaction destruction of cysteine. Early effects of estrone (an estrogen) administered in vitro on liver slices of adult roosters were studied. Increased rates of incorporation of acetate into fatty acids and lipids, amino acids into total protein, and uridine into RNA were observed to occur; all varied as functions of the level of estrogen and duration of incubation. Evidence is presented which indicates that unique organelles, referred to as transosomes, are elaborated at the surface of follicular cells. The function of these transosomes is described. Synthesis of DNA in graft complexes between DNA synthesizing cells and cells in the early part of the cell cycle that precedes the onset of DNA synthesis was investigated in Stentor coeruleus. Results strongly suggested that cytoplasmic regulation of DNA synthesis was mediated by an initiator rather than an inhibitor. Initial studies with sodium dodecysulfate and urea on circular dichroism measurements of horseradish peroxidase revealed conformation-dependent Cotton effects at 209 and 220 mμ. The "helical" Cotton effect at 220 mμ was relatively stable and enzymic activity was retained when this Cotton effect was not altered. Glycerolphosphate dehydrogenase (GPDH) synthesis in the brain of x-irradiated rats was compared to radiation doses administered. A difference in GPDH activity between control and irradiated animals was not apparent until a few days post-irradiation. It was concluded that there was no repair mechanism in the dividing cell population of the brain. The heads of 20-day-old rats were x-irradiated and a loss of DNA in brain tissues within the first 24 hours was produced. This observation and radioisotope experiments seemed to imply that at 2 to 16 days of age, x-irradiation of the brain degraded DNA and inhibited its synthesis. Glycolytic rates of tissues from the cerebrum cortex, brain stem and medulla oblongata of normal and x-irradiated rat brains (750 R to the head at 2 days of age) were measured. Aerobic glycolysis tended to be enhanced in irradiated brain tissues and the Pasteur effect seemed to be inhibited. A discussion on the investigation of the effects of increased oxygen tension on the production of an erythropoietic inhibitor following irradiation is presented. A method for cardiac blood pool scanning with ^{99m}Tc-labeled albumin was designed and the results obtained were satisfactory. The effects of DL-glyceraldehyde, 6-mercaptopurine, methotrexate, and 5-fluorouracil on Ehrlich ascite carcinomas in mice were investigated. DL-glyceraldehyde was more effective against the tumor than any of the three compounds with which it was compared. Combination of glyceraldehyde and 5-fluorouracil resulted in a slight potentiation of carcinostatic effect. DL-glyceraldehyde at carcinostatic dose levels was shown to have little toxic effect. Longevity, growth rate, the incidence of certain diseases, the time of onset of characteristic features of the aging process, and the state of the lifetime health of 433 newborn rates were observed following a single exposure to 0, 5, 25, or 125 R whole-body x-irradiation on the fourth postnatal day. Results were summarized and presented. (B.H.S.)

20035 (UCLA-12-612, pp 69-76) BIOPHYSICS. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

The time course of the appearance of tyrosinase activity induced in 3-day old mycelial pads of Neurospora grown in liquid media was followed. The radiosensitivity of the tyrosinase system to 8000 R γ radiation was also determined. Preinduction radiation treatment and the addition of 2 mM ethionine inducer acted independently on the tyrosinase repressor and accelerated the appearance of tyrosinase. Experiments are planned to measure tyrosinase activity as a function of radiation dose. A viable cell electrophoretic separator was used to separate lymphocytes from whole blood. These lymphocytes did not grow as well in cell cultures as nonseparated lymphocytes. Investigations for elucidation of this phenomenon are outlined. The separator was observed to work very well on fractionation of bone marrow suspensions. Experiments on the possibilities of direct spark enhancement of tritium microradioautographs, the behavior of radiochromium tagged tetracycline, and hexokinase activity assays on red blood cell fractions were instituted. (B.H.S.)

20036 (NP-tr-1487) INFLUENCE OF IRRADIATED AQUEOUS NaCl SOLUTIONS ON THE VISCOSITY OF TISSUE NUCLEOPROTEINS. Malina, Yu. F.; Tseitlin, M. I. Translated by J. E. Baker (Atomic Energy Research Establishment, Harwell, Eng.), from pp 91-6 of Rol' Perekisnei i Kisloroda v Nachal'nykh Sta-

tilakh Radiobiologichesogo Effekta, Izdatel'stvo Akademii Nauk, Moscow, 1960. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Viscosity changes were studied both during irradiation of DNP solutions and on addition of an irradiated 1M NaCl solution to DNP solutions. It was observed that in the former case the viscosity decreased, while in the latter case it increased. It is concluded that two processes take place during irradiation of DNP solutions. The first results in a drop in the viscosity of the macromolecular solutions and is apparently associated with the short-lived free radicals HO and HO_2. The second process, leading to viscosity increase, is due to the formation of long-lived active substances under the action of radiation on the water. When DNP solutions are irradiated the first process predominates and the overall effect is a reduction in viscosity. When, however, irradiated water is added to a DNP solution the free radicals are excluded from the system and the viscosity increases. The results are very fully discussed and are stated to be interesting in connection with direct and indirect effects in biological systems. (INIS-UK)

20037 ZINC CONTENT AND SUBCELLULAR DISTRIBUTION IN RED VS. WHITE PORCINE SKELETAL MUSCLE. Cassens, R. G.; Hoekstra, W. G.; Faltin, E. C.; Briskey, E. J. (Univ. of Wisconsin, Madison). Amer. J. Physiol., 212: 688-92(Mar. 1967).

Radioactivity of various porcine skeletal muscles varied fourfold 47 days following intravenous injection of ^{65}Zn. Specific activities (counts/min per μg Zn) of various skeletal muscles did not differ greatly, and it was concluded that under the conditions used ^{65}Zn concentration was therefore a rough indicator of muscle total zinc concentration. Red skeletal muscles had a three- to fourfold higher zinc content than did white muscles. In newborn pigs differences in zinc content among muscles were minimal but by 8 weeks of age the marked difference was found between red and white muscles. Red muscles showed a large increase in zinc concentration from birth to 8 weeks of age, whereas white muscles showed little change or a small decline. The difference in zinc content between a typical red (high-zinc) muscle and a white (low-zinc) muscle was found, by centrifugal separation of muscle homogenates, to be confined to the heavy fraction which was composed primarily of myofibrils and nuclei. Zinc content of the supernatant fraction was similar in red and white muscle, and mitochondrial and microsomal fractions accounted for only a small portion of the total muscle zinc in both types of muscle. (auth)

20038 SENSITIVITY OF ARTEMIA EGGS TO γ-IRRADIATION. VIII. MODIFICATION OF AMOUNT OF RADIATION-INDUCED FREE RADICALS BY POST-IRRADIATION TREATMENTS. Iwasaki, Tamiko (National Inst. of Radiological Sciences, Chiba, Japan). Int. J. Radiat. Biol., 11: 153-9(1966).

The effects of heat or hydration treatment after irradiation on hatchability of, and the decay of free radicals in dry eggs of Artemia were examined. Immediately after irradiation with 480 kR of ^{60}Co γ rays, the eggs were heated at 100°C for 5 min, or hydrated at 4°C for 30 min, and re-desiccated with the aid of a vacuum pump for 2 hours. After these treatments, the hatchability of eggs did not change if they were examined just after treatment, but the amount of free radicals produced by irradiation instantly decreased as measured by electron spin resonance. In the irradiated eggs, the hatchability decreased during storage for one week under dried conditions. After post-irradiation heat treatment, the decrease in hatchability was reduced. If the irradiated eggs were hydrated, re-desiccated and stored for a few weeks, the hatchability did not decrease during the storage period. Free radicals in the irradiated eggs decayed rapidly after heat or hydration treatment. The possible role of the decay of free radicals in biological damage to the eggs under these conditions is discussed. (auth)

20039 STUDIES ON METABOLISM IN LIVER OF WHOLE-BODY X-IRRADIATED MICE. Streffer, Christian (Univ., Freiburg i. B.). Int. J. Radiat. Biol., 11: 179-91(1966). (In German).

The content of glycogen, glucose, pyruvate, lactate, acetoacetate, β-hydroxybutyrate, and malate as well as the activity of glycogen-phosphorylase and FDPase were measured in liver of x-irradiated mice (690 R). The content of glycogen and glucose decreased after irradiation when the animals were fed ad libitum, but increased in animals that were starved for 24 hours. The values for pyruvate rose during the first hours after irradiation. With starved mice a second increase appeared 9 to 14 days after irradiation. The content of lactate and malate was enhanced with starved animals some days after irradiation. The ratio lactate/pyruvate first decreased and then rose. The ratio β-hydroxybutyrate/acetoacetate, as well as the total amount of both metabolites, diminished in the tissue of starved mice after irradiation. Although the activity of glycogen-phosphorylase was unchanged in the liver of irradiated animals, an increase in FDPase activity was measured 7 to 9 days after irradiation. (auth)

20040 THE INCREASED SENSITIVITY OF THE DEOXYRIBONUCLEOPROTEIN COMPLEX OF IRRADIATED TISSUES TO THE ACTION OF HEPARIN. Skalka, M.; Matyasova, J. (Inst. of Biophysics, Brno). Int. J. Radiat. Biol., 11: 193-6(1966).

Dose-dependency and relation to time of the increased release of DNA by DNP from spleen and thymus under the influence of heparin were studied in x-irradiated mice. Changes in DNA sensitivity to heparin were studied at various time-intervals (2 to 24 hrs) after exposure to 600 R. Two hours after exposure both the amount of deoxyribopolynucleotides and of DNA released by spleen into the solution under the action of heparin on DNP increased. Values obtained in experiments with thymus show a similar course. The relation between radiation dose and DNP sensitivity to heparin within 6 hrs of irradiation was investigated and compared with the level of release deoxyribopolynucleotides in the thymus of irradiated mice. Deoxyribopolynucleotide levels first rose steeply with dose; at higher doses they remained at almost the same level. Values of DNA released from DNP yield a similar dependence on dose. Results with spleen were similar. Data confirm previous reports that the DNP complex of irradiated tissues is several times more sensitive to the action of heparin as compared to nonirradiated controls. Mechanisms of the reaction are discussed. (H.G.D.)

20041 DEPENDENCY OF THYMIDINE INCORPORATION ON IRRADIATION DOSE. Smets, L. A. (Univ. of Nijmegen, Netherlands). Int. J. Radiat. Biol., 11: 197-9(1966).

The dose-effect curve for thymidine incorporation in DNA after x-irradiation (450 R) of monolayer cultures of bovine liver cells was examined. Incorporation rates per cell were calculated from the measured DNA specific radioactivity divided by the fraction of cells in DNA synthesis scored in the autoradiographs from cultures that received corresponding doses of x rays. When the values were plotted semilogarithmically as percentages of controls, the shape of the curve relating radiation dose and rate of DNA synthesis depended on the type of tracer used. Phosphorus-32 produced an essentially monophasic curve that coincides with the shallow component of the diphasic curve. It is suggested that DNA breakdown after irradiation takes place only in strands that are in the process of being synthesized and not in strands already synthesized at the onset of irradiation. (H.G.D.)

20042 EXTRATERRESTRIAL LIFE DETECTION BASED ON OXYGEN ISOTOPE EXCHANGE REACTIONS. Kok, Bessel; Varner, Joseph E. (Research Inst. for Advanced Studies, Baltimore). Science, 155: 1110-12(Mar. 3, 1967).

A method for detecting extraterrestrial life, based on catalysis of isotopic oxygen exchange between water and oxygen-containing anions such as phosphate, nitrate, or sulfate is described. Catalytic activity appears to be unique to living systems. Its applicability requires very few assumptions concerning the chemical nature of life. Data obtained indicated that the experiments were sound and technically feasible. (auth)

20043 THE INTERCONVERSION AND REUTILIZATION OF INJECTED ^{75}Se-SELENOMETHIONINE IN THE RAT. Awwad, Hassan K.; Adelstein, S. James; Potchen, E. James; Dealy, James B. (Harvard Medical School, Boston). J. Biol. Chem., 242: 492-500(Feb. 10, 1967).

Some aspects of the immediate and long term metabolic fate of injected ^{75}Se-selenomethionine were studied in the rat. In addition to radioselenomethionine, two radioseleno compounds were detected in the precursor amino acid pool of the liver as well as in the hydrolysates of liver proteins and serum albumin. The two compounds had the chromatographic mobility of L-cysteine and L-cystine in two solvent systems. Specific activity of a sulfur amino acid was defined as the ^{75}Se radioactivity associated with a measured quantity of the chromatographically separated amino acid. The changing specific activity of L-methionine and L-cysteine + L-cystine in the precursor pool, liver protein hydrolysate, and serum albumin resembles a precursor-product relationship. The serum albumin synthesis rates calculated from these curves are consistent with the known turnover rates of serum albumin in the rat. The data suggest the formation in tissues of the radioseleno analogues of L-cysteine and L-cystine. Evidence is presented which indicates the efficient reutilization of one or more of the selenoamino acids. (auth)

20044 EFFECT OF WHOLE-BODY GAMMA IRRADIATION ON RAT PLASMA PHOSPHOLIPIDS AND THE EFFECT OF S-β-AMINOETHYLISOTHIOURONIUM BROMIDE HYDROBROMIDE. Naqvi, Saida; Misra, U. K.; Venkitasubramanian, T. A. (Univ. of Delhi). Indian J. Biochem., 3: 236-8(1966).

No change in total phospholipid content of rats, subjected to an irradiation dose of 1000 R, was observed 6 hr after irradiation, but 24 hr after irradiation a slight increase was noticed in the irradiated rats as compared to the control group. This increase was not normalized to the control level by administration of 2-

(2-aminoethyl)-2-thiopseudourea dihydrobromide (AET) before irradiation. The plasma phospholipids, separated into monophosphoinositides, lysolecithin, sphingomyelin, lecithin and phosphatidyl ethanolamine by silicic acid paper chromatography, showed that whole body gamma irradiation of rats significantly elevated the monophosphoinositide content of plasma and that this increase was corrected by AET administration. Lysolecithin, lecithin and phosphatidyl ethanolamine contents were reduced significantly in the irradiated rats. The results showed that the administration of AET alone influenced the phospholipids pattern of rat plasma. (auth)

20045 EFFECT OF WHOLE BODY GAMMA IRRADIATION ON TISSUE LIPIDS OF RATS AND THE EFFECT OF S-β-AMINOETHYLISOTHIOURONIUM BROMIDE HYDROBROMIDE. Naqvi, Saida; Misra, U. K.; Venkitasubramanian, T. A. (Univ. of Delhi). Indian J. Biochem., 3: 244-9(1966).

The effect of whole body gamma irradiation with 800 and 900 R on liver, brain, spleen and kidney lipids of rats, 4 and 24 hr after irradiation, has been investigated in the presence and absence of 2-(2-aminoethyl)-2-thiopseudourea dihydrobromide (AET). No change was observed in liver lipids, total cholesterol, phospholipids and neutral lipids of rats 4 hr after irradiation. Total lipids of liver and brain, and cholesterol of brain, liver and kidney decreased 24 hr after irradiation with 980 R. AET administration prevented these changes except in the case of liver total lipids and kidney cholesterol, where a decrease was observed. Liver phospholipids decreased and spleen phospholipids increased in irradiated rats, and these changes were prevented by AET administration before irradiation. Various fractions of liver lipids of control and experimental groups of rats irradiated with 800 R, separated by silicic acid column chromatography, showed that irradiation with 800 R significantly reduced esterified cholesterol concentrations. AET administration before irradiation did not prevent these alterations. A significant increase in liver lecithin and a significant decrease in phosphatidyl ethanolamine and sphingomyelin was observed in irradiated rats. AET administration before irradiation did not prevent these changes. A significant decrease in esterified and free cholesterol, and a significant increase in polyglycerophosphatide fraction was observed in untreated control group of rats administered AET. Also, in untreated control group of rats administered AET, changes were observed in phospholipid and free fatty acid levels of brain and kidney, and in total lipid levels of kidney and spleen. (auth)

20046 WHOLE-BODY RETENTION OF ^{86}Rb IN THE YOUNG AND ADULT MICE. Matsusaka, Naonori; Inaba, Jiro (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 16: 78-82(Feb. 1967).

The whole-body retention of ^{86}Rb was investigated in mice of 7, 21, and 98 days old. The effect of age on the ^{86}Rb retention in mice was observed clearly. It was found that the suckling mice of 7 days old had a very unusual retention pattern, in which the biological half-time was 11 days. The biological half-times of ^{86}Rb in 21 and 98 day-old mice were 2.5 and 3.5 days, respectively. There were no significant differences in the retention values between oral and intraperitoneal administration, and ^{86}Rb was absorbed almost completely from the gastrointestinal tract. (auth)

20047 EFFECTS OF TEMPERATURE ON THE RADIOSENSITIVITY OF RIBONUCLEASE. Guenther, Wolfgang; Jung, Horst (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 22b: 313-20(Mar. 1967). (In German).

The radiosensitivity of dry ribonuclease was determined at various temperatures ranging from 90 to 300°K and using ^{60}Co gamma radiation, 2-MeV protons, and 2-MeV deuterons. The cross section for the inactivation of RNase S(T) is, in this range, given as a function of temperature by $S(T) = S_0 + S_1 \cdot e^{-E_a/RT}$. For inactivation of ribonuclease with gamma rays $S_0 = 0$ and $E_a = 1000$ cal/mole; $S_1 = 0.125$ Mrad^{-1} when irradiation is carried out in vacuo, and $S_1 = 0.265$ Mrad^{-1} in oxygen. With protons and deuterons the following values were determined: $S_0 = 1.28 \times 10^{-14}$ cm^2, $S_1 = 19.5 \times 10^{-14}$ cm^2, $E_a = 1050$ cal/mole for 2-MeV protons; $S_0 = 2.45 \cdot 10^{-14}$ cm^2, $S_1 = 31 \cdot 10^{-14}$ cm^2, and $E_a = 1050$ cal/mole for 2-MeV deuterons. By analysis of some recent data from the literature it was found that the cross section for inactivation by ionizing radiation of various enzymes, bacteriophages, and bacterial spores in the range from 4°K to temperatures higher than room temperature can satisfactorily be described by the more general equation $S(T) = S_0 + S_1 \cdot e^{-E_1/RT} + S_2 \cdot e^{-E_2/RT}$, with $E_1 = 1$ kcal/mole and $E_2 = 4$ kcal/mole being constant for all objects and for all circumambient conditions tested. This correlation between inactivation cross section S(T) and temperature T shows three mechanisms of inactivation to occur in biological objects: one (S_0) being independent of temperature, while the two others have apparent activation energies of 1 and 4 kcal/mole, respectively. (auth)

20048 IONIZING RADIATION EFFECTS ON CONTRACTILE FUNCTIONS OF FROG STRIATED MUSCLES. Nadareishvili, K. Sh.; Saneblidze, O. I. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 44: 741-8(Dec. 1966). (In Russian).

Isolated preparations of the sartorius, gastrocnemius, and rectus abdominis muscles were exposed to x radiation. An inhibitory effect on tetanic contractions was observed following maximal stimuli. The muscle twitch response was increased by small doses of x radiation. This effect was observed as long as the total dose did not exceed 60 krad. With larger doses the effect was inhibitory. (H.L.W.)

20049 SOLUBILITY OF RAT THYMUS AND SPLEEN DEOXYRIBONUCLEOPROTEIN IN NEUTRAL SALT SOLUTIONS AFTER IRRADIATION IN VIVO. Chlumecka, Vera; Skalka, M. (Inst. of Biophysics, Brno). Folia Biol. (Prague), 12: 374-81(1966).

The thymus and spleen deoxyribonucleoprotein (DNP) complex of rats irradiated with an exposure of 1,000 R underwent a damage, manifested in raised solubility of the DNP in neutral NaCl solutions of high ionic strength. Similar changes were observed in purified deoxyribonucleohistone preparations obtained from the thymus of irradiated rats by the method of Zubay and Doty. No significant postirradiation changes occurred in the solubility of the DNP of the other tissues tested (liver, kidneys and testes). The solubility of thymus and spleen DNP rose with the postirradiation interval. Maximum values for thymus DNP were attained 24 hours, and for spleen DNP 14 hours, after irradiation; at subsequent intervals they were again lower. The solubility of thymus DNP rose with the dose up to an exposure of 1,000 R. (auth)

20050 DISTRIBUTION AND EXCRETION OF NIOBIUM FOLLOWING INHALATION EXPOSURE OF RATS. Thomas, Robert G.; Thomas, Randi Lie; Scott, James K. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Amer. Ind. Hyg. Ass. J., 28: 1-7(Jan.-Feb. 1967).

Two single-exposure inhalation studies on rats were carried out for purposes of following the excretion and tissue distribution patterns of niobium with time, using niobium-95 as a radioactive tracer. For the first exposure the aerosol was generated from an oxalic acid solution containing only the tracer; for the second, the solution contained an additional quantity of stable niobium-93. Twice as much of the carrier aerosol was initially deposited in the whole animal, but only one-half as much of this larger particulate material was initially associated with the lower respiratory tract. One repeated exposure experiment was carried out, and the pattern of buildup and loss of niobium-95 from the whole body indicated that the hazard from chronic inhalation of this material could be assessed from calculations based on data derived from a single exposure. (auth)

20051 EFFECTS OF THERMAL DENATURATION ON THE RADIOLYTIC YIELD OF DNA IN SOLID PHASE. Krsmanovic-Simic, Draga; Van De Vorst, Albert; Richir, Marc (Univ., Liege). Int. J. Radiat. Biol., 11: 171-8(1966). (In French).

Electron spin resonance is used to determine the x- and γ-ray-induced free radicals in denatured DNAs. The results obtained are identical to those that characterize, under the same conditions, the corresponding undenatured substances. Determination of the radioresistance of these macromolecules, as measured by this method, is thus independent of their secondary structure. (auth)

20052 DISTRIBUTION OF CALCIUM AND STRONTIUM IN THE BLOOD OF THE LAYING HEN. Creger, C. R.; Ansari, M. N. A.; Colvin, L. B.; Couch, J. R. (Texas A and M Univ., College Station). Proc. Soc. Exp. Biol. Med., 124: 799-800(Mar. 1967).

Serum collected from a hen that was given 25 uCi ^{85}Sr was separated on Sephadex G-25 column and found to contain ^{85}Sr activity only in the nonprotein fractions. On the other hand, the serum of a control hen showed the Ca to be present in both protein and nonprotein fractions. These data suggest that, unlike Ca, Sr is not bound to proteins in the blood. (auth)

20053 THE INFLUENCE OF ANTIBIOTICS ON CHANGES IN THE IMMUNOLOGIC SPECIFICITY OF PROTEINS IN ACUTE RADIATION SICKNESS. Mil'man, M. Sh. (Inst. of Roentgenology, Radiology, and Oncology, Tashkent). Byull. Eksp. Biol. Med., 62: No. 11, 85-7(Nov. 1966). (In Russian).

The object of study was the influence of penicillin, streptomycin, and oxytetracycline on processes causing changes in the immunologic specificity of proteins in rabbits irradiated in a dose of 600 R. A change in the immunologic specificity of proteins was determined by the method of anaphylaxis followed by desensitization. It has been found that 30 minutes after irradiation, changes occur in the antigenic structure of the liver proteins and that streptomycin

and oxytetracycline exert an influence on processes leading to a change in the immunologic specificity of proteins. (auth)

20054 ON THE INCREASE OF BIOLOGICAL ACTIVITY OF EXTRACTS OF THE HYPOTHALAMUS IN EARLY STAGES AFTER IONIZING RADIATION. Smirnova, N. P.; Andrianova, L. A. Byull. Eksp. Biol. Med., 63: No. 2, 25-8(Feb. 1967). (In Russian).

Experiments on rabbits and rats after ionizing radiation showed an increase of biological activity of extracts of the hypothalamus 3 hours after gamma-irradiation. (auth)

20055 HISTOCHEMICAL INVESTIGATION OF ACTIVITY OF SUCCINIC DEHYDROGENASE IN THE SMALL INTESTINE OF ANIMALS UNDER THE ACTION OF PENETRATING RADIATION. Strelina, A. V. (Central Research Roentgen-Radiological Inst., Leningrad). Byull. Eksp. Biol. Med., 63: No. 2, 113-17(Feb. 1967). (In Russian).

Histochemical methods with the use of nitro-BT show that with total irradiation of mice and rats with doses of 600, 2000 and 4000 R there takes place activation of restoration of tetrazolium salt during oxidation of succinate in the small intestine. The rapidity of the onset and the degree of activation depend directly on the radiation dose. Activation of the process is explained as a result of radiation lesion of the cytochrome system and cytochrome oxidase. Data are given which speak in favor of radioresistance of succinic dehydrogenase. (auth)

20056 THYMINE AND URACIL-THYMINE DIMERS AND DEOXYRIBONUCLEIC ACID SYNTHESIS IN MAMMALIAN CELLS IRRADIATED WITH ULTRA-VIOLET LIGHT. Klimek, Miros; Vlasinova, Miluse (Inst. of Biophysics, Brno). Int. J. Radiat. Biol., 11: 329-37(1966).

The ability of synchronized mammalian L cells to synthesize DNA during different time-intervals (between 1 and 24 hours) after different doses of uv light was studied. Thymine and uracil-thymine dimers formed in the DNA of irradiated cells do not completely block the DNA-synthesis. Cells irradiated with doses between 0 and 200 ergs show a pronounced decrease in their ability to synthesize immediately after irradiation with DNA. But later on the amount of DNA synthesized by these cells gradually approaches the amount of DNA synthesized by non-irradiated cells. This process is dose-dependent. Slow replication around the dimer block, resulting in production of mutated DNA together with the existence of many chromosomes with multiple origins of replication in a mammalian cell offer possible explanation of these findings. (auth)

20057 EFFECTS OF ^{210}Po ON MOUSE OVARIES. Samuels, L. D. (Harvard School of Public Health, Boston). Int. J. Radiat. Biol., 11: 117-30(1966).

Female mice were injected intraperitoneally with ^{210}Po, and the localization in ovary and uterus and effects on oocyte survival were studied. Radioautographic studies showed that ^{210}Po was localized primarily in the follicle cells of the ovary, whereas it was distributed diffusely through the myometrium of the uterus. Significant killing of primary oocytes occurred after exposure to as little as one picocurie of ^{210}Po per gram body-weight, and larger amounts of Po killed almost all the oocytes and grossly distorted the architecture of the ovary. The pathological changes seen were typical of those visible after exposure to radiation, but dose estimates suggest that in some cases the RBE for ^{210}Po alpha-particles may be as high as 50 or more compared with ^{60}Co gamma-rays. The kinetics of killing were those ascribed to single-hit killing. The data fit a dose-effect plot without a threshold. (auth)

20058 GAMMA-IRRADIATION OF NUCLEIC-ACID CONSTITUENTS IN DE-AERATED AQUEOUS SOLUTIONS. I. CYTOSINE. Khattak, M. N.; Green, J. H. (Univ. of New South Wales, Sydney). Int. J. Radiat. Biol., 11: 131-6(1966).

De-aerated aqueous solutions of cytosine (concentration 10^{-2}M) were γ-irradiated by a ^{60}Co source. The resultant pale-yellow solutions were analyzed by paper chromatography. By using various solvent systems, the contents of the irradiated solutions were separated into five different constituents. These were uracil (a deaminated hydroxylation product), 5 and 6-hydroxy cytosines, 5,6-dihydroxy cytosine and hydroxy-hydro cytosine. Their radiation yields were measured. (auth)

20059 GAMMA-IRRADIATION OF NUCLEIC-ACID CONSTITUENTS IN DE-AERATED AQUEOUS SOLUTIONS. II. 5-METHYL CYTOSINE. Khattak, M. N.; Green, J. H. (Univ. of New South Wales, Sydney). Int. J. Radiat. Biol., 11: 137-43 (1966).

Initial radiation decomposition yields for the γ-radiolysis of de-aerated aqueous solution of 5-methyl cytosine have been measured. The identification and yields of ammonia, 5-hydroxymethyl cytosine, thymine and cis and trans 5-methyl cytosine glycols are reported. (auth)

20060 ON THE "PHOSPHATATIC" ACTION OF THORIUM AND ZIRCONIUM IONS ON LECITHIN AND SOME OF ITS METABOLITES AS SUBSTRATES. Sir, Stanko; Rezek, Adolf (Veterinarski Fakultet, Zagreb). Enzymologia, 31: 355-62(Dec. 31, 1966). (In German).

The ability of Th and Zr ions to dephosphorylate phosphoric acid esters, i.e., to act as phosphatases, was investigated on substrates with a quaternary N atom: lecithin, glycerylphosphorylcholine, and phosphorylcholine. Results were compared to those obtained with glycerophosphate. The pH ranged from 1 to 9.5. Phosphorylcholine was hydrolyzed by both ions over this entire range of pH, but more intensively by Th^{4+} (yet less intensively than glycerophosphate), optimally at pH ranging from 3 to 5 (about 20%, glycerophosphate over 60%) and even more so at a pH of 9.5 (about 50%, glycerophosphate over 70%). Optimal hydrolysis with Zr^{4+} was achieved only at a pH of 6.2 (13%). Hydrolysis of the di-esters, glycerylphosphorylcholine and lecithin, was much slower than that of phosphorylcholine and glycerophosphate but was more intensive with glycerylphosphorylcholine than with lecithin. The effect of each ion was also differentiated by hydrolysis of the diesters. Thus, Th^{4+} hydrolyzed glycerylphosphorylcholine over the entire pH range (up to pH of 8, below 5%), but optimally only at a pH of 9.5. Lecithin was hydrolyzed from pH 5 upwards (0.4%), but optimally at pH 9.5 (about 9%). Conversely, Zr^{4+} dephosphorylated glycerylphosphorylcholine from pH 3.2 upwards, optimally at pH 7 (about 10%) and less intensively above that (6%). Lecithin was dephosphorylated only from pH 6.2 upwards, optimally also at pH 7 (about 1%), but was not affected at pH 9.5. The mechanism of the effect produced by Th^{4+} and Zr^{4+} on these substrates was interpreted in terms of a scheme proposed for the explanation of their effect upon a number of other investigated substrates. Differences in the activity of Th^{4+} and Zr^{4+} were regarded as consequences of the known differences in the properties of these ions or their hydroxides. The constant K_m for the effect of Th^{4+} on glycerophosphate at pH 5 was $\sim 0.6 \times 10^{-3}$. (BBB)

20061 ACTIVE SODIUM AND POTASSIUM TRANSPORT IN CELLS OF BARLEY ROOTS. Pitman, M. G.; Saddler, H. D. W. (Univ. of Adelaide). Proc. Nat. Acad. Sci. U. S., 57: 44-9(Jan. 1967).

Results are reported from studies on active Na and K transport in cells of barley (Hordeum vulgare) roots grown in a culture solution containing ^{22}Na and ^{42}K. The roots were excised at intervals for assay of tracer uptake, and the fluxes of Na and K in excised barley roots were estimated from the rate of tracer exchange. Results indicate an active Na extrusion and K uptake. Possible mechanisms involved are discussed. (C.H.)

20062 STUDIES OF ^{47}Ca METABOLISM IN ACROMEGALY. Bell, Norman H.; Bartter, Frederic C. (National Institutes of Health, Bethesda, Md.). J. Clin. Endrocrinol. Metab., 27: 178-84(Feb. 1967).

Calcium and phosphorus metabolism was studied in 4 patients with acromegaly, 2 of whom had received pituitary irradiation. Calcium and phosphorus balance, exchangeable calcium (P'), calcium "accretion" rate (vo+) and "bone resorption" rate (vo−) were measured. In all patients there was a negative calcium balance; in 3 of them there was a negative phosphorus balance. Urinary calcium was moderately increased in the 2 untreated patients, and normal in the 2 treated patients. In all patients, vo+ and vo− were abnormally increased. These results are comparable to those which have been produced in normal subjects with human growth hormone. These findings support the view that vo+ and vo− are abnormally increased in acromegaly and that the increase results from growth hormone. The possible relationship of the results to osteoporosis is discussed. (auth)

20063 RELEASE OF FREE DEOXYRIBONUCLEIC ACID IN RAT THYMOCYTES AFTER WHOLE-BODY IRRADIATION. Perris, A. D.; Whitfield, J. F. (National Research Council, Ottawa). Int. J. Radiat. Biol., 11: 399-402(1966).

Thymocyte suspensions were prepared from rats sacrificed at different times after 1000 R ^{60}Co irradiation. These were analyzed for pyknotic nuclei, free DNA, and deoxyribonucleoprotein. Structurally homogeneous (pyknotic) nuclei increased rapidly to almost 80% of the cells at 6 hr. Free DNA remained constant for 2 hr, then rose. This accompanied an equivalent decrease in the deoxyribonucleoprotein content. Extraction of DNA with phosphate buffer gave much higher yields than sodium chloride extraction. The action of phosphate is discussed. Results also confirm observations that post-irradiation measures which prevent phosphate uptake (such as anaerobiosis in vivo) prevent release of free DNA and dissolution of normal nuclear structure of thymocytes. (C.O.)

20064 ELECTRON SPIN RESONANCE STUDIES OF RADIATION DAMAGE IN DEOXYRIBONUCLEIC ACID. Cook. J. B.;

Wyard, S. J. (Guy's Hospital Medical School, London). Int. J. Radiat. Biol., 11: 357-65(1966).

Electron spin resonance (ESR) spectroscopy has been used to make quantitative and qualitative measurements on irradiated deoxyribonucleic acid. Radical yields in six different samples are compared with those determined by other workers. The ESR spectrum shows that the radiation produces at least two radical species, and the nature of one of these is discussed in detail. (auth)

20065 EFFECTS OF STORAGE AND OF IRRADIATION BY X RAYS ON THE IN VITRO FIBRINOLYTIC ACTION OF STREPTOKINASE–STREPTODORNASE. Szirmai, E.; Berkada, B.; Akodan, G. (Inst. of Nuclear Engineering, Stuttgart). Agressologie, 7: 493-9(1966). (In French).

Fibrinolytic activity of a preparation of streptokinase-streptodornase (SK-SD), which contained 20,000 units SK + 5000 units SD, was studied. This preparation of SK-SD (Varidase) was stored for periods up to 2 yr, and irradiated with 200-KV x rays or ^{60}Co γ rays. The activity of the preparation was not altered by 2-yr storage nor by irradiation of 1200-R. Anticoagulant activity was still present as assayed by all of the coagulation systems tested (clotting time of recalcified plasma, clotting time of thrombin, fibrinolytic activity, and the autocoagulogram). (BBB)

20066 EXCISION OF DIMERS AND HYDRATES FROM ULTRAVIOLET-IRRADIATED POLY U BY PANCREATIC RIBONUCLEASE. Pearson, Mark (Stanford Univ., Palo Alto, Calif.); Johns, H. E. J. Mol. Biol., 19: 303-19(Aug. 1966).

Hydrolysis of uv-irradiated poly U (uridylic acid) by pancreatic RNase resulted in the formation of 3 major photoproducts: Hp (3′-uridylic acid hydrate), Dp (uridylyl-(3′,5′)-uridine-3′-phosphate dimer), and DpHp (the trinucleotide in which the first 2 are dimerized and the 3rd hydrated), as well as unaffected Up (3′-uridylic acid) and other minor products. Irradiation drastically reduced the rate of hydrolysis of poly U by RNase. The hydrolysis products were isolated from ^{32}P-labeled poly U by 2-dimensional paper chromatography, thus allowing the determination of the amount of dimer and hydrate formed in uv-irradiated poly U as a function of dose. As an example, the yields of the 4 major products formed by 280 mμ irradiation are given. Dimers were reversed by re-irradiation at 240 mμ, while hydrates were reversed by heating at 85°C. Hydrolysis of the major dimer-containing oligonucleotides with bacterial alkaline phosphatase established their chain length as 3, while hydrolysis with snake venom phosphodiesterase released D (uridylyl-(3′,5′)-uridine dimer), pU, and pH. DpU was split at about 14 times the rate of DpH by the snake venom enzyme, while both DpU and DpH were stable to spleen phosphodiesterase. Alkaline hydrolysis of these trinucleotides confirmed their structures as determined enzymically. Two isomeric dimers were found in irradiated poly U. Attempts at heat reversal of hydrates in dimer-containing oligonucleotides led to extensive breakdown of these products, emphasizing the need for controls on chain integrity during thermal reactivation of irradiated polynucleotides. (BBB)

20067 EFFECTS OF ELECTROMAGNETIC RADIATIONS ON PHYSIOLOGIC RESPONSES. Michaelson, Sol M.; Thomson, R. A. E.; Quinlan, William J. Jr. (Univ. of Rochester, N. Y.). Contracts AF30 (602)-2248; W-7401-eng-49. Aerospace Med., 38: 293-8(Mar. 1967).

Studies were performed on dogs exposed to 1240 Mc/sec pulsed microwaves, at a field intensity of 50 mW/cm^2, six hours per day for five consecutive days. Some dogs with additional exposures were included. For comparison, dogs previously irradiated with 1000 kVp x rays (50 R/min) either to the whole-body (300 R) upper-body (1900 R) or lower-body (900 R) were exposed to microwaves in similar manner. Alterations in cardiopulmonary, thyroid and erythropoietic function of normal dogs and greater sensitivity of x irradiated dogs to microwaves are noted. In general, these studies indicate that repeated exposure to 1240 Mc/sec microwaves at 50 mW/cm^2, can produce functional changes in the dog which if extrapolated to man would be indicative of homeostatic insufficiency and decrement in performance capability even though overt incapacitation may not take place. Whether thermal, non-thermal, or both of these are the contributing factors in the response to microwave exposure, there are sufficient experimental and human survey evidence to indicate that microwave exposure results in alteration in compensatory and homeokinetic mechanisms of the body. The effects of microwave exposure at 50 mW/cm^2 in the normal animal should alert us to the caution that has to be exerted when any consideration is given to raising the presently accepted maximum permissible exposure of 10 mW/cm^2. (auth)

20068 INVESTIGATION OF THE FATE OF LABELLED LIVER DEOXYRIBONUCLEIC ACID INJECTED INTO IRRADIATED AND NONIRRADIATED ANIMALS. Becarevic, Aleksandar; Petrovic, Svetozar; Jankovic, Vera; Kanazir, Dusan. Bull. Boris Kidrich Inst. Nucl. Sci., 17: 211-18(July 1966).

The distribution and localization of labeled DNA-thymidine-^{14}C injected intraperitoneally into irradiated and nonirradiated (control) rats have been investigated. In the course of 30 minutes more than 50% of highly-polymerized DNA-thymidine-^{14}C is resorbed from the peritoneum of animals, and 9 hours after injection less than 10% of injected DNA remains in the peritoneum. During the first 30 minutes after injection most of the activity is found in the DNA fraction of the recipient liver cells. In this period about 1.7% of the total injected activity is found in the liver cells. Thirty-seven percent of the incorporated activity is found in nonirradiated animals. This activity may be produced by larger fragments of injected DNA incorporated into the liver cells. In irradiated animals the appearance of activity is much slower which suggests that either the mechanisms of DNA-^{14}C fragment incorporation are damaged, or the incorporated fragments decompose more rapidly. Neither the intestinal nor the spleen cells show any considerable amount of activity in the first few hours after DNA-^{14}C injection. Later appearance of activity (after 6 hours) in the DNA of these organs may be due to the metabolic utilization of mononucleotides of degraded exogenous DNA-^{14}C, or to the temporarily inhibited or delayed synthesis of the DNA of intestinal and spleen cells in irradiated animals. (auth)

20069 EFFECT OF X RAYS ON THE AEROBIC ENERGETIC METABOLISMS. Carraz, Gilbert; Rinaldi, Renaud; Moisant, Raymonde; Leonardi, Marco (Centre d'Etudes Nucleaires, de Pharmacodynamie, Grenoble, France. Institut des Isotopes, Grenoble, France). Compt. Rend., Ser. D, 263: 423-5(July 25, 1966). (In French).

The effect of soft x rays on the metabolic activity of hematic, striated muscle, and hepatic cells in suspension was investigated. The oxygen consumption was the parameter tested. For the muscular and hepatic cells the statistical analysis of the data shows no variation of the oxygen consumption caused by irradiation. For the hematic cells the increase of the oxygen consumption after irradiation at 300,000 R is statistically significant. (J.S.R.)

20070 THE RADIOSENSITIVITY EFFECTS OF LACTIC DEHYDROGENASE ON IN VITRO CULTURES OF EMBRYONIC CHICK TISSUES. Kirrmann, Jean-Michel (College de France, Nogent-sur-Marne, France. CNRS, Nogent-sur-Marne, France). Compt. Rend., Ser. D, 263: 426-9(July 25, 1966). (In French).

X rays exert an inhibitory effect on the activity of lactic dehydrogenase in vitro in cultures of chick embryo tissues. If it is measured 4 hrs after irradiation, the inhibitory action is proportional to the logarithm of the x-ray dose administered (between 2 and 900 kR). It was observed that recovery of enzymatic activity occurs in 24 to 48 hrs when doses less than or equal to 7.5 kR are given. (tr-auth)

20071 ACTIVITY OF TRANSAMINASES IN THE RAT SERUM AFTER INTERNAL CONTAMINATION WITH ^{137}Cs AND ^{90}Sr. Stojadinovic, Svetan; Jovanovic, Milan (Boris Kidric Inst. for Nuclear Sciences, Belgrade). Strahlentherapie, 131: 633-6(Dec. 1966).

The effect of radioactive cesium-137 and radioactive cesium and radioactive strontium mixture (^{90}Sr) was examined in relation to the activity of GPT and GOT serums. The activity of GPT serum increased after intoxication while the activity of GOT remained unchanged. (auth)

20072 EFFECTS OF PROTEIN DEFFICIENCY ON DIGESTIVE ABSORPTION AND TISSUE DISTRIBUTION OF ABSORBED ^{59}Fe IN THE MALE RAT. EFFECTS OF ERYTHROPOIETIN INJECTIONS. Aschkenasy, A. (CNRS, Montrouge, France). Rev. Franc. Etud. Clin. Biol., 11: 1010-22(Dec. 1966). (In French).

Male rats were provided with balanced and protein-free diets and the absorption and distribution of ^{59}Fe, administered either by intravenous injection or by a stomach tube, was determined. A third group of rats underwent a period of protracted nitrogen starvation (7 weeks) and were then placed on an 18% casein diet; the effects of injections of rat plasma rich in erythropoietin on the absorption of ^{59}Fe in the protein derived rats were determined. Rats were sacrificed either 24 hr or 7 days after the administration of ^{59}Fe. The absorption of ^{59}Fe in rats decreased strongly after protracted nitrogen starvation (10.2 ± 3.5%), but it was almost normal (24.6 ± 4.1%) if the ^{59}Fe was administered after the first week of protein-free diet. It was precisely at the beginning of this period that an almost complete suppression of erythropoietic utilization of the absorbed ^{59}Fe (0.10 ± 0.03%) was observed. On the contrary, after 7 weeks of nitrogen starvation erythropoietin utilization became more marked (1.87 ± 0.27%), although it remained below normal (7.32 ± 1.68%). Injections of rat plasma rich in erythropoietin considerably enhanced the erythropoietic utilization of absorbed ^{59}Fe at the beginning of nitrogen starvation

(2.47 ± 0.33%), but did not increase absorption of the isotope. It was concluded that iron absorption did not depend on the level of erythropoietin in protein deprived rats. If after 7 weeks of protein deprivation rats were given a balanced diet, a striking increase in ^{59}Fe absorption occurred simultaneously with an increase in ^{59}Fe incorporation into erythrocytes. On both balanced and protein-free diets, the percentage of ^{59}Fe absorbed in the gastro-intestinal (GI) tract that was retained by erythropoietic tissues was less than the corresponding percentage of intravenously administered ^{59}Fe. However after one week of a protein-free diet, the absorbed ^{59}Fe did not accumulate in the liver as did the intravenous ^{59}Fe under the same dietary conditions. A fraction of intravenously-injected ^{59}Fe was always excreted in the fecal material; however, much more ^{59}Fe was retained in the walls of the GI tract if the diet was devoid of proteins than if it were well balanced. (B.H.S.)

20073 RADIOISOTOPE TAGGING THROUGH SEED SOAKING. Monk, Carl D. (Univ. of Georgia, Athens). Bull. Ga. Acad. Sci., 25: No. 1, 13-17(Jan. 1967).

Corn and oat plants were grown from seeds soaked for 24 hours in separate solutions of ^{65}Zn, ^{59}Fe, and ^{45}Ca. Iron and calcium were present in sufficient quantities for a variety of mineral cycling or plant-animal relationship studies. The seed-tag method was found to possess several advantages over the various well-inoculation and foliar-application methods; mass tagging was more easily accomplished, direct contamination problems were circumvented, and the fate of the isotope could be followed in all stages of plant development. (auth)

20074 EXISTENCE OF COLLECTIVE EXCITATION ENERGY LOSSES FROM AN ELECTRON BEAM PASSING THROUGH BIOLOGICAL MATERIALS. Johnson, C. D.; Rymer, T. B. (Univ. of Reading, Eng.). Nature, 213: 1045-7(Mar. 11, 1967).

In radiobiology the transfer of energy from ionizing radiation to an absorber is often expressed in terms of the mean energy transferred per primary ionization and the number of such ionizations per gram of absorber. Energy losses from an electron beam passing through thin organic films have recently been measured. Very few electrons showed energy losses of less than 10 to 12 eV, and the most probable loss was about 25 eV. For electron beams of energy between 5 and 20 keV the mean energy loss per primary ionization was found to be 60 ± 10 eV, a value considerably less than the 100 eV estimated from data on gases and from Bethe calculations. The difference may result from the existence in solids of energy loss processes which do not occur in gases. Collective excitation of valency electrons is a possible mechanism. It is important to know if such processes occur in biological materials, and the present note describes some studies with calf thymus nucleic acid. Radiation damage to specimens was minimized. Evidence was obtained that collective losses exist and are important in radiobiology. The lifetime of the collective excitation states is of the order of 10^{-15} sec. and, although the nature of the decay process is not fully understood, there is the possibility that the energy is finally dissipated in the rupture of a number of chemical bonds over a region much larger than that associated with the ion cluster. This could significantly affect determinations of radiation sensitive volumes by Lea's associated volume method. (auth)

20075 EFFECTS OF IONIZING RADIATION ON THE HAIR-BULBS OF YOUNG RATS. Smoliar, V. (Univ., Liege). Int. J. Radiat. Biol., 11: 21-6(1966).

The histological changes in the hair-bulbs of young rats exposed to a whole-body x irradiation of 500 R were investigated by autoradiography. ^{3}H-thymidine was injected at various times before and after the irradiation, and the percentages of labelled pycnotic and mitotic nuclei were scored at selected time-intervals after the exposure. The early wave of cell destruction was found to be due to cells which had completed their DNA-synthesis at the time of irradiation; the abortive mitotic recovery consisted of cells in the S phase at the time of exposure, while the second pycnotic wave probably represented mainly degenerated daughter cells of the first post-irradiation division. Comparison of these results with previous data obtained in animals pretreated with cystamine suggests that a repair mechanism is involved in the chemical protection of the rat hair-bulb. (auth)

20076 THE ACTION OF CHELATING AGENTS ON ^{212}Pb IN THE BLOOD: THE PARTICULAR VALUE OF THE STEADY STATE AFTER ^{228}Th ADMINISTRATION TO THE BEAGLE. Stover, Betsey J.; Ruhmann, Ann G.; Atherton, David R. (Univ. of Utah, Salt Lake City). Int. J. Radiat. Biol., 11: 27-34(1966).

An animal that has previously been injected with ^{228}Th has a significant steady-state concentration of ^{212}Pb in its blood. The steady-state nature of the system offers several unusual aspects for the study of removal of lead from blood by chelating agents. First, the system regenerates itself so that one animal can be used for a series of studies. Second, since ^{212}Pb is being produced continuously, the temporal course of effect of the chelating agent can be followed. Third, since there is ^{212}Pb elsewhere in the animal, the effect of the chelating agent in removing lead from tissue deposits can be determined. This model applied to the beagle has been used to investigate the effect of amount of chelating agent administered, the comparative effectiveness of equimolar amounts of three chelating agents, and the comparative effectiveness of subcutaneous and oral administration. (auth)

20077 AUTORADIOGRAPHIC STUDIES OF THE DISTRIBUTION OF ^{210}Po IN MICE AFTER A SINGLE INTRAVENOUS INJECTION. Soeremark, Rune; Hunt, Vilma R. (Harvard Univ., Boston). Int. J. Radiat. Biol., 11: 43-50(1966).

This short-term autoradiographic study has been undertaken to give survey distribution patterns of all organs and tissues simultaneously before severe tissue changes due to radiation damage were apparent. The results confirmed earlier autoradiographic studies. In addition, we have shown the importance of the accumulation of polonium in the placenta, the uptake in the organic matrix of bone. High concentrations were also found in the lacrymal and mammary glands, the meninges, and in the intestinal wall. (auth)

20078 SURVIVAL OF HeLa CELLS AFTER LARGE DOSES OF X-RADIATION. Lund, Ebba; Rosengren, Bengt (Univ. of Goteborg). Int. J. Radiat. Biol., 11: 99-102(1966).

Prolonged incubation revealed that single cells of bottle cultures of HeLa cells may survive even 20,000 R to form colonies of apparently normal cells with unimpaired growth capacity and sensitivity for virus. (auth)

20079 SOME ASPECTS OF ELECTRICAL PROPERTIES OF NORMAL LIVER AND MALIGNANT HEPATOMA. Nagarajan, B.; Sivaramakrishnan, V. M. (Cancer Inst., Madras, India). Indian J. Cancer, 2: 103-5(June 1965).

Interaction of ^{60}Co and ^{65}Zn with normal liver and malignant hepatoma cells induced by feeding azo dye was studied and the results interpreted in terms of the electrical charges of the cells. Cancer was induced in Wistar rats by feeding dimethylaminoazobenzene for 6 to 8 months, and hepatoma and normal liver cell suspensions were prepared. Uptake of ^{60}Co and ^{65}Zn by these cells was then studied in vitro. Various chelating agents which were tested had a profound effect on the metal ion incorporation by the tissue preparations. In normal liver cells, 1-nitroso-2-naphthol, Oxine and EDTA inhibited the uptake of ^{60}Co, EDTA having the max inhibition effect. Rubeanic acid did not have a significant effect but in hepatoma increased the uptake. In the case of ^{65}Zn, except for EDTA, the chelating agents used showed an increased uptake; however, the uptake by tumor cells was always higher than the control cells. BAL considerably inhibited the reaction both in the case of ^{65}Zn and ^{60}Co. The effect of increasing the ion concentration was studied. As the concentration increased there was a decrease in the incorporation of the metal. With ^{60}Co, tryptophan enhanced the uptake while histidine had a depressing effect. With ^{65}Zn, proline and leucine slightly inhibited and histidine to a considerable extent inhibited uptake. In liver tumors the amino acids lysine, methionine, and tryptophan enhanced the incorporation probably because of lower content of these amino acids. The depressing effect of EDTA on the in vitro uptake of ^{60}Co by the liver cells confirms the earlier observation that EDTA administered simultaneously with ^{60}Co reduces the deposition of the latter in the liver to negligibly low levels. (BBB)

20080 SOME CHANGES IN THE ACTIVITY OF THE L-GLUTAMATE-NAD-OXIDO-REDUCTASE IN THE LIVER OF RATS WITH GUERIN EPITHELIOMA AND AFTER IRRADIATION WITH X-RAYS. Trandafirescu, M.; Ababei, L. (Inst. of Medicine and Pharmacy, Iassy, Rumania). Acta Biol. Med. Ger., 17: 250-1(1966). (In German).

Glutamate dehydrogenase (GLDH) activity was studied in liver homogenates of normal rats, of rats with Guerin epithelioma and multiple metastasis, and of rats x irradiated with 500 R on the fifth day after tumor implantation. The GLDH activity in the liver of rats with the Guerin epithelioma was 20% greater than in normal rats; after irradiation this activity was 12% lower than in the normal rats. Addition of $ZnSO_4$ in a concentration of 9×10^{-5}M slightly increased the enzymatic activity in the normal liver; the increase in the liver of tumor-bearing animals was about 38%. The same concentration of $ZnSO_4$ caused a decrease in the activity of 28% in irradiated rat liver when it was added to the homogenate. With a concentration of $ZnSO_4$ of 1.9×10^{-4}M there was total inhibition of the enzyme both in irradiated and normal rat liver, in contrast with the tumor-bearing liver, in which this concentration raised the enzymatic activity by about 10% from its level without $ZnSO_4$. At a $ZnSO_4$ concentration of 1.75×10^{-4}M, there was total GLDH inhibition in normal and irradiated liver, whereas in the tumor-implanted rats, the activity was increased. It is suggested that the structure of the enzyme, which is dependent on Zn ion for activity, is altered in tumor-implanted and irradiated rats. (BBB)

20081 EFFECTS OF TRIS-β-CHLOROETHYLAMINE, 2,4,6-TRIETHYLENEIMINO-1,3,5-TRIAZINE, AND X RADIATION ON DEOXYRIBONUCLEASE II OF RATS. Tempel, Karlheinz; Roessner, Walter; Zipf, Karl (Univ., Munich). Strahlentherapie, 131: 623-32(Dec. 1966). (In German)

Determinations have been made of in vitro activity of acid deoxyribonuclease (DNase II) of brain, spleen, thymus, and serum of rats between 8 hours and 28 days after intraperitoneal injections of Sinalost® (HN 3) and Triethylenemelamine® (TEM) and total body X-irradiation (TBI) with 1070 and 2140 R. DNase II of spleen and thymus is increased significantly within 8 to 16 hours after TBI or application of HN 3 and TEM. Increase was highest within 16 to 24 hours after TBI and within 2 to 3 days after treatment with the alkylating agents. Maximal values surpassed—in dependency on dose, mode of damage and sex—the controls by about 100 to 300%. Within 3 days (TBI: spleen) or 10 days (TBI: thymus, HN 3, TEM) normal values have been reestablished. Total in vitro activity of DNase II of spleen and thymus was increased within 16 to 24 hours after TBI or HN 3-treatment by 20 to 50%. The increase of DNase II-activity of brain surpassed control values only by about 10 to 20% and was demonstrable mainly under influence of HN 3. Under the influence of TBI, HN 3 and TEM in vitro activity of DNase II of serum is also increased. The K_m have been determinated of DNase II of the spleen when increase of in vitro activity was maximal after TBI or treatment with HN 3 and TEM. The K_m of the damaged spleens were lower by about 15 to 30% than the K_m of DNase II of the spleens of untreated animals. Causes of DNase II-reaction described may be relative enzyme enrichment and/or induction of synthesis. It is suggested that DNase II plays an important role in necrolysis of cell nuclei damaged by ionizing radiations or alkylating agents. (auth)

20082 ENRICHMENT OF POLYSOMES IN THE LIVER UPON X-IRRADIATION IN VIVO. (PRELIMINARY REPORT). Hidvegi, E. J.; Holland, J.; Boeloeni, Elisabeth; Varteresz, V. (Inst. for Radiobiological Research, Budapest). Acta Biochim. Biophys., Acad. Sci. Hung., 1: 107-12(1966).

Male guinea pigs, body-weight 350–400 g, fasted overnight were irradiated with 600 R (200 kv, dose rate 52.1 R/min, whole body). The animals were killed at appropriate intervals, and the livers quickly excised and homogenized in 0.25M sucrose. The homogenate was centrifuged at 15 000 X g for 15 min and the supernatant at 105 000 X g for 60 min. Microsomes suspended in 0.25M sucrose were analyzed by sucrose density gradient centrifugation. The ribosomal fraction isolated from unirradiated animals contained a high amount of monomers (50–60%). At 2 hr after irradiation the amount of polysomes was increased, and 12 to 15 hr after irradiation the monomer ribosomes constituted an appreciably minor part (30 to 40%) of the ribosomal fraction. Electron microscopic observations and analytical ultracentrifugal analysis confirmed these results. The radiation-induced enrichment of polysomes does not reflect artificial aggregation of ribosomes, since they could be degraded either by endogenous or exogenous ribonuclease digestion. To examine the protein-synthesizing ability of ribosomes, total particles were incubated with ^{14}C-amino acids in a cell-free system. Incorporation of amino acids by the ribosomes was slightly higher 2 and 4 hr after irradiation as compared to the unirradiated control and kept on increasing between 9 to 15 hr. When ^{14}C-amino acids were injected into the animals a short time (60 min) after irradiation with a higher dose (1800 R) and the animals killed 11 hr later, more radioactivity was found in the ribosomal preparation isolated from the liver of x-irradiated animals. Most of radioactivity appeared in the polysome fraction. It is proposed that irradiation enhanced either the synthesis of messenger RNA's on their transfer from the nucleus to the cytoplasm, or both. Either would explain the enrichment of polysomes and increased amino acid incorporation. (BBB)

20083 EFFECT OF ADSORPTION ON THE RADIATION SENSITIVITY OF TRYPSIN. Loefroth, Goeran; Augenstein, Leroy (Michigan State Univ., East Lansing). Contract AT(11-1)-1155. Arch. Biochem. Biophys., 118: 73-81(Jan. 1967). (TID-22858).

Many of the properties of trypsin molecules were changed when they were adsorbed at an air-quartz or air-glass interface. For example, contrary to some radiobiological postulates, the uv radiosensitivity of trypsin at these air-solid interfaces was either the same as or less than that for trypsin in solution. Also, at 228 nm the absorbance of trypsin films was 1.7 that in solution, suggesting that adsorption either caused preferential orientation of some of the transition dipoles relative to the interface or else caused conformation changes. Further, the extent of the change in inactivation yield apparently depended upon the polarization of the light relative to the interface. Thus, presumably excitation of certain electronic transitions was more effective in initiating enzymic inactivation than was excitation of others. Similar to ultraviolet effects in solution, the inactivation yields for the trypsin films measured by an assay employing hemoglobin in 5 M urea were 2.5 times as large as those utilizing only buffer and BAEE substrate. By contrast, the temperature coefficients for inactivation of adsorbed trypsin were different than those observed in solution for a comparable temperature range. The equation yield for trypsin on the slides was not changed by rather large alterations in the relative humidity nor by flushing the samples with N_2 or air during irradiation. (auth)

20084 DEPENDENCE ON WAVELENGTH OF PHOTOPRODUCT YIELDS IN ULTRAVIOLET-IRRADIATED POLY U. Pearson, Mark (Stanford Univ., Palo Alto, Calif.); Whillans, D. W.; LeBlanc, J. C.; Johns, H. E. J. Mol. Biol., 20: 245-61(Dec. 1966).

The yield of dimer and hydrate photoproducts in uv-irradiated ^{32}P-labeled poly U (uridylic acid) was determined as a function of exposure over the wavelength range 225 to 289 mμ using a method involving ribonuclease hydrolysis and paper chromatography. The cross-sections for dimer and hydrate formation are the same as in UpU over the complete wavelength range. However, the dimers formed in poly U are not randomly spaced throughout the chain, but tend to appear in sequences of more than one dimer. As a result of this clustering of dimers, the cross-section for total dimer formation is about 3 times that for the formation of the trinucleotide product. These results indicate that pre-existing photoproducts can affect the rate of photochemically converting neighboring sites in a polynucleotide chain. It is speculated that the rapid formation of adjacent dimers may be due to energy transfer within the poly U random coil structure. (BBB)

20085 MODIFICATION OF RADIATION DAMAGE AND ELECTRON SPIN RESONANCE MEASUREMENTS IN VICIA FABA SEEDS. Klingmueller, Walter (Univ., Giessen, Ger.). pp 261-5 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

Radiation sensitivity of very dry seeds is much higher than that of seeds with medium water content. This was confirmed with Vicia faba minor seeds of different progenies and under different experimental conditions. In very dry embryos of V. faba minor seeds, 10,000 R of x rays induced a detectable amount of free radicals, about 7×10^{15} per g dry weight, while in embryos of medium water content, no such radicals could be found. By investigating cotyledons and testae separately, it was found that similar concentrations of free radicals were induced by irradiation in both cotyledons and embryo. In testae, however, many more free radicals could be detected. Evidence was found that even simple illumination induces free radicals in the testa of V. faba minor, not only in dry material but in some of medium water content as well. Seeds of 2 moisture contents at irradiation (9.7 and 10.4%) were given 3000 or 10,000 R doses of x rays, and were soaked 4 min after irradiation for an initial period of 8 hr under either aerobic or anaerobic conditions. They were then grown in sawdust. In contradiction to earlier reports, radiation damage was marked in these samples soaked 4 min after irradiation, while beans of higher water content (12%) showed no damage at all. Apart from the irradiation and from moisture content, no other treatment gave significant differences. There was no difference between aerobic and anaerobic soaking, nor did aerobic soaking have any effect on the ultimate radiation damage. (BBB)

20086 EFFECT OF SOIL HUMIC ACIDS ON UPTAKE OF FISSION PRODUCTS BY EXCISED ROOTS. Tatsukawa, Ryo (Univ. of Tokyo); Franklin, R. E. Soil Sci. Soc. Amer., Proc., 30: 460-2(July-Aug. 1966).

The relative availability to plants of fission products complexed with soil organic matter was studied, as well as some of the factors affecting availability. Two-phase membrane equilibrium systems were used to examine complexing humic acids with fission products and the effect of complexing on the uptake of fission products by excised roots of barley, corn, and soybean. Humic acids from Rifle peat and an Alaskan peat were purified by centrifugation and resin column treatment. Higher concentrations and greater uptake of the fission products ^{59}Fe, ^{90}Sr, ^{106}Ru, and ^{137}Cs from the Rifle peat humic acid suspensions than from equilibrium dialyzates indicated some form of complexing of the isotopes with the organic matter. The humic acid from the Alaskan peat exhibited very little suspension effect as measured by uptake. (BBB)

20087 MAGNESIUM TRANSPORT IN NORMAL AND UREMIC PATIENTS. Wallach, Stanley; Rizek, Juan E.; Dimich, Alexandra; Prasad, Nallur; Siler, William (State Univ. of New York, Brooklyn). J. Clin. Endrocrinol. Metab., 26: 1069-80(Oct. 1966).

The kinetics of radiomagnesium exchange in normal and uremic subjects was studied by administering high specific activity ^{28}Mg intravenously and utilizing conventional and analog and digital computer techniques of data analysis. In normal subjects, the extracellular magnesium (0.35 mEq/kg) exchanged with 2 tissue

magnesium pools having sizes of 2.05 and 0.27 mEq/kg and bidirectional flux rates of 0.13 and 0.55 mEq/kg/hr, respectively. A third tissue magnesium pool of indeterminate size with an influx rate of 0.029 mEq/kg/hr and a negligibly small fractional efflux rate was also present. Urinary excretion of ^{28}Mg averaged 10.4% dose/72 hr in the normal subjects and their urine specific activities were maintained at levels which were 23 to 40% higher than those of the plasma. In uremic patients with hypermagnesemia, the extracellular magnesium was increased to 0.79 mEq/kg. The fractional coefficients for influx into the 2 bidirectionally exchangeable tissue magnesium pools and the unidirectionally exchangeable tissue magnesium pool were decreased by 60%. Therefore, despite hypermagnesemia, the sizes and flux rates of these pools were normal. Urinary excretion of ^{28}Mg was reduced to 44% of normal and urine specific activities were 19 to 26% higher than those of plasma. These data suggest that one tissue magnesium pool, because of a finite influx rate but a negligibly small fractional efflux rate, is capable of maintaining a specific activity above that of the plasma, and conventionally calculated exchangeable body pools of magnesium may not provide a true estimate of magnesium exchangeability. The urinary data further suggest the presence of a magnesium fraction with this characteristic in renal tubular cells. In hypermagnesemic uremia, an excessive intracellular accumulation of magnesium does not occur since the cellular structures involved in magnesium transport have the ability to reduce the fractional rate of cellular influx of magnesium upon exposure to an elevated extracellular concentration of magnesium. Studies of experimental hypermagnesemia suggest that this is a physiologic response to hypermagnesemia, which is not impaired in the uremic state. (auth)

20088 MAGNESIUM TRANSPORT IN PATIENTS WITH THYROID DISEASE. Dimich, Alexandra; Rizek, Juan E.; Wallach, Stanley; Siler, William (State Univ. of New York, Brooklyn). J. Clin. Endocrinol. Metab., 26: 1081-92(Oct. 1966).

The kinetics of radiomagnesium exchange in hyper- and hypothyroid patients was studied by administering high specific activity ^{28}Mg intravenously and utilizing conventional and analog and digital computer techniques of data analysis. In hyperthyroidism, the size of the largest of the 3 exchangeable tissue magnesium fractions derived from the digital computer analysis was increased by 58% compared to control subjects, and in hypothyroidism the size was decreased by 24%. The flux rate of magnesium was increased by 60 to 120% in all 3 tissue fractions in the hyperthyroid patients compared to the hypothyroid patients. The urinary excretions of ^{28}Mg and ^{24}Mg were 80% greater in the hyperthyroid and 30% smaller in the hypothyroid patients than in the control subjects. In the 4 patients restudied after restoration of euthyroidism, some or all of the abnormalities in magnesium transport returned toward normal. The data indicate that thyroid hormone has a direct stimulatory action on the cellular transport of magnesium. The ability of thyroid hormone, as well as altered extracellular concentrations of magnesium, to influence the cellular transport of magnesium is indicative of a regulated process involving either active transport or facilitated diffusion. A probable but not invariable result of the hormonal stimulation of magnesium transport appears to be a preservation of normal cellular concentrations of magnesium despite a tendency to depletion of extracellular magnesium in hyperthyroidism and to an excess of extracellular magnesium in hypothyroidism. (auth)

20089 FLUCTUATIONS IN RATE OF PROTEIN SYNTHESIS IN THE NUCLEI OF IRRADIATED HeLa CELLS. Kalenko, G. S.; Kuzin, A. M. (Inst. of Biophysics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 170: 966-9(Oct. 1, 1966). (In Russian).

The initial rates of inclusion of ^{3}H-DL alanine changed periodically in both the nucleus and the cytoplasm of irradiated HeLa cells. The rates gradually decreased during the first 20 minutes and then gradually increased. With a short exposure (5 minutes), these fluctuations were even more distinct. The situation was reversed when ^{3}H-uridine was used. During the first 10 to 20 minutes the rate of inclusion into RNA was the highest. Irradiation did not have any perceptible effect on the decomposition of rapidly synthesized protein. It is concluded that the pattern revealed reflects a definite rhythm in the metabolic processes existing in the cells. (auth)

20090 EFFECT OF RED CELL AGING ON ^{51}Cr BINDING AND IN VITRO ELUTION. Awwad, Hassan K.; Moussa, Laila; Sheraki, Ahmed S. (Medical Research Inst., Alexandria, United Arab Republic). J. Nucl. Med., 7: 687-95(Sept. 1966).

Differential osmotic lysis and centrifugal separation of red cells were used to study the relationship between red cell age and ^{51}Cr-hemoglobin binding and in in vitro elution of the label during electrophoresis. The hemoglobin specific activity was uniform in hemolysates obtained by graded saline hemolysis except for the 1.0% most fragile cells, which showed a higher specific activity. The previously reported higher specific activity of the top cells separated by centrifugation was also shown. Labeling of red cells with radiochromate did not alter the pattern of osmotic fragility and density relationship between old and young cells. The elution of label during electrophoresis was significantly higher from solutions obtained from old cells than from that of relatively young cells. Washing of cells with phosphate buffered ACD markedly reduced the elution of label. Artificial induction of increased fragility resulted in a marked increase in the rate of elution. The significance of these findings in the interpretation of in vivo ^{51}Cr-labeled red cell survival curves is discussed. (auth)

20091 MATHEMATICAL MODEL FOR COPPER METABOLISM AND ITS RELATION TO WILSON'S DISEASE. Hazelrig, Jane B.; Owen, Charles A. Jr.; Ackerman, Eugene (Mayo Clinic and Mayo Foundation, Rochester, Minn.). Amer. J. Physiol., 211: 1075-81(Nov. 1966).

Radioactive copper has been used in studies of copper metabolism by isolated perfused rat liver. These results suggested a model involving certain nonlinearities. The model postulates at least three distinct hepatic processes: (a) preparation of copper for excretion in the bile, (b) temporary storage of copper, and (c) incorporation of copper into ceruloplasmin with the final compartment involved in the production of labeled ceruloplasmin having limited capacity. When specific variations of this model were simulated on an analog computer, deviations between theoretical and experimental values were within the range of experimental error. The liver storage compartment could provide an emergency means for removing ionic copper from the blood, thereby preventing its toxic buildup in tissues. The storage compartment may normally represent an intermediate product of ceruloplasmin synthesis which, if partially passed directly into the blood, would account for the biphasic appearance of labeled ceruloplasmin in blood and would be additional evidence for the previously reported heterogeneity of this fraction. Formulation of the mathematical model provides a compact integration of present information and a convenient means for testing additional hypotheses. (auth)

20092 DECOMPOSITION OF TRYPTOPHANS AND KYNURENINS AFTER WHOLE-BODY IRRADIATION IN THE LIVER TISSUE OF MICE. Streffer, Christian; Langendorff, Hans-Ulrich (Univ., Freiburg i. B.). Int. J. Radiat. Biol., 11: 455-63(1966). (In German).

The enzymatic activities of tryptophan pyrrolase, kynurenine aminotransferase, and kynureninase were measured in liver tissue of well fed and starved mice after 690-R x-irradiation. The activity of tryptophan pyrrolase was reduced 12-48 h p.r. as well with the fed as the starved mice. Up to 12 days p.r. there were no further significant changes observed. The kynurenine aminotransferase was slightly increased, while the activity of the kynureninase decreased 1-4 and 7-10 days p.r. The regulating ratio of both activities was therefore changed in the irradiated animal. The analogy between radiation sickness and vitamin B_6 deficiency is discussed. (auth)

20093 ANTIOXIDANTS AND LIPOPEROXIDES IN THE ORGANS OF IRRADIATED RATS. II. THE INFLUENCE OF IONIZING RADIATION ON THE AMOUNTS OF THE INDIVIDUAL ANTIOXIDANTS IN RAT ORGANS. Glavind, Johs. (Polytechnic Inst., Copenhagen); Faber, Mogens. Int. J. Radiat. Biol., 11: 445-8(1966).

The total amount of water-soluble antioxidants in the organs of the rat before and after exposure to high doses of x radiation was estimated together with the individual antioxidants: glutathione, ascorbic acid, and uric acid. A decrease of all three antioxidants was observed after irradiation, and it is concluded that they all serve as free-radical scavengers. Glutathione and ascorbic acid, in varying proportions, are the most abundant antioxidants in rat organs. (auth)

20094 HISTOPATHOLOGY OF THE CEREBELLUM, MEDULLA, AND LABYRINTH OF XENOPUS LAEVIS AFTER HIGH DOSES OF TOTAL-BODY ACUTE IRRADIATION. Treip, C. S.; Divita, G. (Univ. of Cambridge, Eng.). J. Neuropathol. Exp. Neurol., 25: 296-310(Apr. 1966).

A neurological syndrome occurs in irradiated X. laevis: total-body acute irradiation of 30,000 RAD or more causes a severe incoordination of swimming movements. This syndrome does not resemble that of cerebral death with convulsions described in irradiated mammals. The constant presence of well-defined symptoms of ataxia suggested selective and permanent damage to the central nervous system, particularly to the organs controlling equilibrium and coordination of movements. To find focal lesions which might be related to the ataxia, the cerebellum, the labyrinth with the otic ganglion, and the medulla with the vestibular nuclei were examined histopathologically in Xenopus after high doses (30 to 90 Krad) of irradiation. The labyrinth appeared to be undamaged; spongiosis was observed in the medulla and cerebellum; some cellular damage was seen in the Purkinje cells of the

cerebellum and in the neurons of the motor columns. Severe nuclear pyknosis followed by cellular destruction was found in the granule cells of the cerebellum. The results showed the possibility of obtaining coherent histopathological pictures of the central nervous system of vertebrates several days after doses of total-body acute irradiation as high as 80,000 rad. The selective destruction of the cerebellar granular layer observed in irradiated Xenopus offers a comparison with similar findings in mammalian species. Necrosis of the granular layer of the cerebellum of irradiated Xenopus suggests a specific difference in biochemical constituents and metabolic properties between granule and Purkinje cells which is already present in the lower evolutionary stages of the vertebrates, in which the cerebellum has a relatively simple structure. (BBB)

20095 RUBY LASER MICRO-IRRADIATION OF SINGLE TISSUE CULTURE CELLS VITALLY STAINED WITH JANUS GREEN B. II. EFFECTS ON DEHYDROGENASE ACTIVITIES. Storb, R.; Wertz, R. K.; Amy, R. L. (Centre National de Transfusion Sanguine, Paris). Exp. Cell Res., 45: 374-84(Feb. 1967).

The effects of ruby laser irradiation on living cells have been studied histochemically in terms of seven intra- and extramitochondrial dehydrogenases. Single KB cells were stained with nontoxic concentrations of Janus green B, known for its mitochondrial specificity, then subjected to localized microirradiation of the cytoplasm. Beams of several different intensities were employed. The findings were very similar for all enzymes tested. Cells with light, and the majority (84-98 per cent) of those with moderate, primary laser damage had normal dehydrogenase activities although the latter had been shown by electron microscopy to have severely damaged mitochondria. After heavy primary damage, which was typically lethal within 2 hr after irradiation, the majority of the cells (67-94 per cent) exhibited a decrease or a complete absence of dehydrogenase activities. In such cells, ultrastructural changes of virtually all cellular organelles were observed. Most of the cells (79-85 per cent) exhibited cell membrane damage. (auth)

20096 MATHEMATICAL ASPECTS OF THE ULTRAVIOLET PHOTOCHEMISTRY OF POLY U. Johns, H. E. (Univ. of Toronto); Pearson, Mark; Brown, I. H. J. Mol. Biol., 20: 231-43 (Dec. 1966).

Two mathematical models were formulated to predict the yield of dimer and hydrate photoproducts in poly U (uridylic acid). These 2 methods, the Monte Carlo method and the random distribution method, require the use of a digital computer for solution. They were found to give identical results except at large exposures. At large exposures the random distribution method is less accurate than the Monte Carlo method; nevertheless the random distribution method is preferred for practical calculations because of its simplicity and because it requires shorter computing times. In addition, it is easily modified for more complicated reaction schemes. These theoretical models are useful in that they allow the calculation of the relative frequency of any sequence of photoproducts within the population of irradiated poly U molecules. Such calculations of product sequences may be helpful in evaluating the role of dimer and hydrate photoproducts in the uv inactivation of poly U used as a messenger RNA or as a template RNA. (BBB)

20097 DEPLETION OF CALCIUM, PHOSPHATE, AND STRONTIUM FROM ANESTHETIZED CALVES BY HEMODIALYSIS. Downey, H. F. (Univ. of Illinois, Urbana); Stewart, W. E.; Cragle, R. G.; Perry, S. C. J. Dairy Sci., 49: 668-73(June 1966).

Effects of acute depletion of Ca, phosphate, and Sr by hemodialysis were studied in 90-kg, 100-day-old calves. In 1 experiment the calves were intravenously dosed with 3 mCi each of ^{45}Ca, $^{32}PO_4^{=}$, and ^{89}Sr at 48-, 96- or 144-hr predialysis. In the other experiment the calves were each given intravenously 0.25 mCi of ^{85}Sr at 4-, 14-, or 24-hr predialysis. Total Ca depletion of 0.16 g/hr resulted in a 4.8-fold turnover of plasma Ca after 12 hr of dialysis, while only decreasing the plasma Ca concentration by 26%. Plasma P concentration was decreased only 25% by 12-hr dialyses. Plasma concentrations of all isotopes declined significantly during dialysis. The radioactivity removed by dialysis decreased as the time after treatment increased. By the observed ratio technique, depleted ^{89}Sr to ^{45}Ca averaged 1.3–1.4, which confirms that Ca is bound to the plasma proteins more than Sr. Rib epiphyseal ^{45}Ca showed a significant decrease after dialysis. Each isotope followed this trend in a proportional manner. The ^{85}Sr activity in the epiphyseal rib increased during dialyses, begun 4 hr post-treatment. Ability of the young calf to mobilize reserve Ca, Sr, and phosphate was thus demonstrated. (BBB)

20098 LIPASE FROM CANDIDA PARALIPOLYTICA. PART II. ALKALINE EARTH METAL IONS AS THE COFACTOR IN THE SHAKEN SYSTEM CONTAINING NO EMULSIFIER. Ota, Yasuhide; Yamada, Koichi (Tokyo Univ.). Agr. Biol. Chem. (Tokyo), 30: 1030-8(Oct. 1966).

Extracellular lipase from C. paralipolytica required alkaline earth metal ions as a cofactor in a reaction mixture that is not emulsified but dispersed by shaking. This contradicted previous reports that bile salts or anionic surfactants were required as essential activators in systems emulsified with polyvinyl alcohol. The alkaline earth metal ions tested were Ca, Sr, Ba, and Mg. The concentration of $CaCl_2$ producing the maximum reaction rate was 0.03M at pH 8.3 and 0.1M at pH 6.6, and the maximum reaction rates at the two pH values were in the ratio of 1 : 0.72. This ratio was 1 : 0.46 and 1 : 0.16 for $BaCl_2$ and Sr $(C_2H_3O_2)_2$, respectively. Therefore, the pH-activity curve of lipase activity changed depending on the kind of cofactor and its concentration. The role of alkaline earth metal ions during lipolysis by C. paralipolytica lipase seemed to be related to the oil-water interface, i.e., at enzyme adsorption and/or enzyme orientation at the interface. Metal ions were effective only in the nonemulsified system and were not required by water-soluble triacetin. The active enzyme-cofactor complex probably contained one mole of Ca or Ba ion, or 2 moles of Sr ion per mole. The action of the cofactors may have been associated with unknown negatively charged groups, since cationic surfactants were found to be competitive inhibitors. (BBB)

20099 KINETICS OF PHOTODIMERIZATION OF OROTIC ACID IN AQUEOUS MEDIUM. Sztumpf-Kulikowska, Eva; Shugar, D.; Boag, J. W. (Inst. of Biochemistry and Biophysics, Warsaw). Photochem. Photobiol., 6: 41-54(Jan. 1967).

No oxygen effect is normally encountered in the uv-induced transformation of natural nucleic acid derivatives, or of synthetic polynucleotides or natural nucleic acids, but such an effect was, however, observed for orotic acid (6-uracilcarboxylic acid) when irradiated in aqueous medium at 2537 Å. It was shown that uv irradiation of orotic acid in aqueous medium leads to the formation of dimers with a cyclobutane ring between the 5,6 bonds of 2 monomers. These photodimers in turn undergo photodissociation, with the result that an equilibrium is established between photodimerization and photodissociation. The equilibrium point was independent of dose rate, but is dependent on the irradiation wavelength, pH of the medium (i.e., whether the monomer is in the neutral or anionic form), and initial monomer and oxygen concentrations; the effect of oxygen apparently being to deactivate excited monomers. The kinetics of photodimerization and photodissociation were examined at different wavelengths and with varying oxygen concentrations at different initial monomer concentrations. The results were compared with a theoretical model in which it is assumed that a dimer is formed between an excited monomer and second molecule in the ground state, and that oxygen can also react with, and deactivate, an excited monomer. The agreement between the proposed model and the experimental data was reasonably good, and made possible an estimate of the lifetime of the excited state of orotic acid in aqueous medium, which is about 10^{-6} sec. (BBB)

20100 DISTRIBUTION OF TRITIUM IN FATTY ACIDS SYNTHESIZED FROM TRITIATED GLUCOSE AND TRITIATED WATER BY RAT ADIPOSE TISSUE. Foster, Daniel W.; Katz, Joseph (Univ. of Texas, Dallas. Cedars-Sinai Medical Center, Los Angeles). Biochim. Biophys. Acta, 125: 422-7(Dec. 7, 1966).

Fatty acids synthesized by rat epididymal fat-pad slices in the presence of [1-^{3}H] glucose, [3-^{3}H] glucose and tritiated water were degraded for the localization of tritium in the molecule. 75% of the tritium from [1-^{3}H] glucose and 85% from [3-^{3}H]-glucose was present on the odd carbons. The incorporation of 15% of the tritium from [3-^{3}H] glucose in the even positions was unexpected. Tritium from ^3H_2O was incorporated to the same extent in the odd and even positions of the carbon chain. The presence of tritium from water in the odd positions confirms the participation of DPNH hydrogen in reductive fatty acid synthesis in the intact adipose tissue cell. The results with ^3H_2O and [1-^{3}H] glucose resemble those previously reported for liver and suggest that the mechanisms of fatty acid synthesis are essentially similar in the two tissues. (auth)

20101 THE RATES OF OXIDATION OF SOME DEUTERIO ISOMERS OF SUCCINATE DEHYDROGENASE. Vitale, Ljubinka; Rittenberg, D. (Columbia Univ., New York). Contract AT(30-1)-1803. Biochemistry, 6: 690-9(Mar. 1967).

The effect of substitution of deuterium for hydrogen in succinate on the rates of the enzymic oxidation was determined for four isotopic isomers: tetradeuteriosuccinate, α,α-dideuteriosuccinate, (R)-monodeuteriosuccinate, and (S)-monodeuteriosuccinate. The rates of the reaction relative to normal succinate defined as R differed somewhat for enzymes prepared from Escherichia coli, Claviceps purpurea, and beef heart. R was independent of pH

from 6.8 to 8.0. It decreased with ionic strength, temperature, and the concentration of electron acceptor. Malonate was a stronger inhibitor for tetradeuteriosuccinate than for normal succinate; this suggested that the binding of deuteriosuccinate to the enzyme was weaker than that of normal succinate. A deuterated succinic dehydrogenase from E. coli grown in D_2O required a higher malonate concentration for 50% inhibition of the oxidation of normal succinate than the nondeuterated enzyme. Comparison of the rates of oxidation of the four isotopic isomers suggested that the rate-limiting step was the removal of two hydrogen atoms from the substrate. Data were not consistent with a mechanism involving the removal of a hydride ion in the rate-determining step. (auth)

20102 ULTRAVIOLET IRRADIATION EFFECTS IN POLY-L-TYROSINE AND MODEL COMPOUNDS. IDENTIFICATION OF BITYROSINE AS A PHOTOPRODUCT. Lehrer, S. S.; Fasman, Gerald D. (Brandeis Univ., Waltham, Mass.). Biochemistry, 6: 757-67(Mar. 1967).

The blue fluorescence observed in solutions of poly-L-tyrosine, copolymers of tyrosine, and L-tyrosine monomer was due to the production of bityrosine by uv-irradiation. Analogous products were formed by irradiation of other model phenolic compounds. The identification was made by a spectral comparison of the photoproduct with bityrosine and o,o'-bicresol and by a chromatographic and electrophoretic comparison of irradiated polymer hydrolysates and controls. In addition, some spectral characteristics and quantum yields of the bicresol chromophore were obtained in different solvents. It was also shown that the phenomenon of excited state ionization which occurs in aqueous solution did not appreciably occur in solutions of dimethyl sulfoxide. (auth)

20103 UPTAKE AND EXCRETION OF THE NATURAL RADIONUCLIDES ^{210}Pb AND ^{210}Po BY MAN. Gloebel, Beowulf; Muth, Hermann; Oberhausen, Erich (Univ., Saarlandes, Homburg, Ger.). Strahlentherapie, 131: 218-26(Oct. 1966). (In German).

Present investigations were done in order to obtain a survey of ^{210}Pb and ^{210}Po intake with food and drinking water and of the excretion of both these radionuclides in humans. With the instrumentation used, specific activities of ^{210}Pb and ^{210}Po as low as 2×10^{-16} Ci/g of substance can be determined. The results show that a normal person takes in, on the average, 4 to 5 pCi of ^{210}Pb Pb and ^{210}Po per day in the diet. The excretion has the same order of magnitude; great daily variations were observed for intake and excretion. It could be shown that grassy plants take up both nuclides from the soil and from the precipitation on plants above the soil. (auth)

20104 EFFECTS OF ULTRAVIOLET RADIATION ON RNA C-C GLYCOSYLS AND OTHER DERIVATIVES OF URACIL. Lis, Adam W.; Green, Winston R. (Univ. of Oregon, Portland). Radiat. Res., 29: 483-8(Dec. 1966).

The comparative percentages of loss of ultraviolet absorption and restoration of lost absorption show that both the nature of the substituted group and the position occupied by the group influenced the response of the pyrimidine ring. The effects of ultraviolet irradiation and reactivation of RNA C-5 glycosyls, 5-ribosyluracil (pseudouridine), and 1,5-diribosyluracil are compared with 1-ribosyluracil (uridine), uracil, 1-methyluracil, 5-fluorouracil, 5-bromouracil, 1-methyl-5-ribosyluracil, 3-ribosyluracil, 3-methyluracil, 1,5-dimethyluracil (1-methylthymine), 5 methyluracil (thymine), 5-methyluracil deoxyriboside (thymidine), 5-methyluracil riboside (5-methyluridine), and 5-hydroxyuridine (isobarbituridine). Practical applications for the use of rates of hydration are mentioned. (auth)

20105 INVESTIGATION ON BIOLOGICAL RADIOPROTECTION. PART 74. LOCALIZATION AND BEHAVIOR OF RADICALS FROM IRRADIATED BIOCHEMICALS. Koch, Ruprecht; Moenig, Hans (Univ., Freiburg i. B.). Strahlentherapie, 131: 289-97(Oct. 1966). (In German).

The phenomenon of specific energy manifestation is explained. Using the quantity of radicals produced in x-irradiated biochemicals and the behavior and the localization of radical states in adenine, adenosine, adenine nucleotide, and in polynucleotides as well as in methionine, bovine serum albumin, 4- and 5-mercaptopyridoxine, a specific energy manifestation dependent on the molecular structure could be demonstrated. The importance of these findings for the biological radiation mechanism is pointed out. (auth)

20106 STRUCTURAL AND FUNCTIONAL SITES OF ACTION OF ULTRAVIOLET RADIATION IN CRAB NERVE FIBERS. Lieberman, Edward Marvin. Gainesville, Fla., Univ. of Florida, 1965. 186p.

Thesis.

The effects of monochromatic ultraviolet radiations on the function and biochemical structure of crab (Calinectes sapidus) nerve fibers were studied in order to correlate biochemical aspects of the axon membrane with mechanisms of excitability. Single axons from walking leg nerves of the crab were dissected and isolated for electronic stimulation, oscillographic recording and ultraviolet irradiation. Electrophysiological studies demonstrated that irradiation of axons at 285 and 255mμ were equally effective in blocking action potential conduction. The repetitive response was blocked by both 285 and 255mμ radiations, with 255mμ being more effective. The critical firing level (related to a calcium-membrane binding mechanism) and the resting potential and resistance (related to the K^+-conductance mechanism) were also more effectively altered by 255mμ than 285mμ. The critical firing level increased approximately 170 percent and the resting membrane potential and resistance were slightly decreased during 255mμ irradiation. On the other hand, the action potential amplitude, which is a Na^+-conductance dependent characteristic, decayed to a graded response by 285mμ irradiation but was only slightly affected by 255mμ irradiation. Axons were protected from 255mμ but not 285mμ irradiation when suspended in crab physiological solutions containing 0.167 or 2.5 times normal (24 mM/L) calcium concentration. These experiments and others indicated that the optical properties of the membrane were altered so that radiations were scattered away from an inner membrane site associated with the action of 255mμ radiation while not affecting an outer site associated with 285mμ action. Ouabain (10^{-5}M/L), a specific inhibitor of the Na^+-K^+-activated ATPase, had biphasic effects on the repetitive response of crab axons. That is, there was an initial enhancement of the response followed by an inhibition. There was also an eventual decay of the action potential to 50 percent of control amplitude. Ouabain at 10^{-4}M/L, had only inhibitory effects. The effects of higher concentration resembled the combined actions of 285 and 255mμ radiations and 10^{-5}M/L resembled the action of 255mμ. The evidence suggested that a Na^+-K^+-activated ATPase system was involved in the actions of ultraviolet radiations. Homogenation and centrifugation methods were used to prepare a microsomal membrane preparation from crab peripheral nerve which had high Na^+-K^+-activated ATPase activity. The enzyme system was effectively inactivated by both 255 and 285mμ radiations. The system was unaffected by 330mμ which was also found inactive with respect to intact nerve excitability. A model of the structural and functional characteristics of the nerve cell membrane, in which were integrated the electrophysiological, pharmacological and biochemical findings of this investigation, was proposed. The model was constructed to suggest the probable relationship between the phospholipid–cholesterol and protein components of the membrane which are responsible for its passive permeability characteristics. Speculations were made as to the relationship between this structure and Na^+, K^+ and Ca^{++} during the active permeability phase of membrane excitability. Also included in the model were the characteristics of the Na^+-K^+-activated ATPase with respect to Na^+ and K^+ transport and nerve excitability. (Dissertation Abstr.)

20107 STUDY ON DNA DEGRADATION IN ESCHERICHIA COLI PRODUCED BY IONIZING RADIATION. Achey, Phillip Mueller. University Park, Pa., Pennsylvania State Univ., 1966. 65p.

Thesis.

Irradiation of bacteria initiates a breakdown of the DNA molecule. An investigation was carried out to determine the character of this degradation process. The organism Escherichia coli 15 T^-L^-, which requires thymine and leucine for growth, was used in this study. The fate of the DNA was followed by incorporating radioactive labeled ^{14}C-thymine, which is a precursor of the DNA, into the cell. By incorporating the label before irradiation, post-irradiation DNA breakdown could be followed. If the label was applied only after irradiation, DNA synthesis could be followed. An oxygen potentiating effect was found on the radiation action on colony forming ability, DNA synthesis and DNA degradation. Concerning DNA degradation, it was found that degradation could only be initiated when the cells were directly irradiated. Irradiation of the medium alone did not produce degradation. Degradation of the DNA proceeded for approximately 90 minutes following irradiation, after which it essentially stopped. The kinetics and extent of degradation were sensitive to changes in post-irradiation medium, post-irradiation incubation temperature and the type of gas (nitrogen or air) bubbled through the culture after irradiation. This evidence suggests that degradation is an enzymatic process. In addition, cells which were heated to 70°C for ten minutes (which inactivates DNase by a factor of 100) showed no degradation after irradiation. Degradation increased with dose to a maximum level of about 50 per cent at a dose of 20,000 rads, but did not increase with a further increase in dose. A chromatographic study of the products lost by degraded cells indicated that the DNA was broken down to free bases. An autoradiographic study

showed that for a dose of 30,000 rads, there was a similar amount of degradation from cell to cell. (auth)

20108 METABOLISM OF SELENIUM BY RATS AND LAMBS. Ewan, Richard Colin. Madison, Wis., Univ. of Wisconsin, 1966. 219p.

Thesis.

Methods have been perfected for the rapid determination of selenium in plant and animal tissues and for inducing hemolysis in the red blood cells of vitamin E deficient sheep. The analytical method for selenium involves a wet digestion of the organic sample, a coprecipitation of elemental arsenic and selenium, and the measurement of the fluorescence of the 4,5-benzopiazselenol. Red blood cells from vitamin E deficient sheep did not hemolyze under conditions used successfully in other species, but prolonged incubation resulted in virtually complete hemolysis of cells from vitamin E deficient sheep and essentially no hemolysis of those from vitamin E supplemented animals. Nutritional muscular dystrophy (NMD) was produced in lambs by feeding an artificial milk based on torula yeast, and the prophylactic effects of vitamin E and selenium were evaluated. The deficient lambs showed typical symptoms of NMD, viz., inability to rise, elevated glutamic-oxaloacetic trans-aminase and lactic dehydrogenase, high dialuric acid-induced hemolysis of erythrocytes, elevated creatine to creatinine ratio, decreased growth, and reduced survival time. Vitamin E, when given at 22 mg/kg weekly, prevented all symptoms of NMD; selenium at 1.5 ppM of selenium as selenite improved most of these abnormalities, but it did not prevent some increases in enzyme levels and failed to prevent dialuric acid-induced hemolysis of red blood cells. At suboptimal levels of vitamin E, the combination of vitamin E and selenium resulted in better responses than those due to either vitamin E or selenium alone; thus, the vitamin E requirement of the lamb was lowered in the presence of selenium. Selenium alone sustained growth rates equal to those obtained when selenium and vitamin E or vitamin E alone were supplemented. When the dietary selenium was increased, the selenium content of lamb liver and muscle increased, but when the vitamin E intake of the lamb increased, the selenium content of muscle decreased. Labelled selenite injected into young rats was rapidly excreted via the urine, the feces and, at high dose levels, via the expired air. The small percentage that escaped rapid elimination was retained for many months and was excreted only very slowly. During the period of rapid excretion, the amount of selenium in the urine appeared to be a function of the product of the blood selenium-75 level and time after dosage. The elimination of selenium in the expired air was not affected by a variety of fat sources, but was depressed slightly when high levels of vitamin E or antioxidants were fed. The amount of labelled selenium retained after the rapid elimination phase varied with the size of the injected dose, but the rate of depletion thereafter did not. The rate of depletion from the "stable pool" was dependent on the amount of unlabelled selenium ingested during depletion. Loss from the "stable pool" was unaffected by changes in the diet which hasten selenium deficiency (torula yeast), which increase volatilization during the first 24 hours (high protein and methionine or Purina Chow) or which diminish toxicity (linseed meal) except as these diets varied in selenium content. The same general elimination pattern was observed in lambs given an oral dose of radioactive selenate when retention was estimated from the selenium-75 excreted in the urine and feces. When lambs were given labelled selenate, the liver, kidney, large intestine and spleen contained the highest concentrations of selenium-75 one week after administration. The concentration of selenium in most tissues decreased with time, but in wool, whole blood, and erythrocytes, the highest concentrations were reached at 4 weeks and then decreased. Residual selenium-75 was small in all tissues after 30 weeks, and only 2.0% of the total selenium present in the muscle at 30 weeks originated from the test dose. (Dissertation Abstr.)

20109 THE EFFLUX OF ^{24}Na AND ^{42}K FROM THE ISOLATED GIANT AXON OF THE LOBSTER (HOMARUS AMERICANUS). Houck, David J. Buffalo, State Univ. of New York, 1965. 94p.

Thesis.

A technique for isolating and incubating the giant axon of the lobster (Homarus americanus) to determine the sodium-24 and potassium-42 loss is described. The time constant (τ) for sodium efflux at 3° is 72 minutes and the time constant for efflux at 25° is 23 minutes. The Q_{10} for sodium efflux over this temperature range is 1.6. This value is less than the comparable value for the squid axon. Treating the axon with 10 mM sodium azide increases the time constant (τ) of sodium efflux to 84 and 74 minutes at 3° and 25°. Both the Q_{10} and metabolic inhibitors suggest that sodium efflux in the lobster axon is an active process as it is in the squid axon. Assuming a 60 mM intracellular sodium concentration, sodium effluxes are 46 pmoles cm^{-2} sec^{-1} and 139 pmoles cm^{-2} sec^{-1} at 3° and 25° respectively. These effluxes are larger than the corresponding effluxes from the squid axon; but the intracellular sodium concentration may not be as large in the lobster axon as in the squid axon. The time constant for potassium efflux from the isolated axon is 80 minutes at 3° and 58 minutes at 25°. If we assume an intracellular potassium concentration of 360 mM, then the corresponding resting effluxes from the axon are 227 pmoles cm^{-2} sec^{-1} and 322 pmoles cm^{-2} sec^{-1} respectively. Like the sodium effluxes the potassium effluxes from the lobster axon are proportionately larger than the corresponding effluxes from the squid axon. Both the Q_{10} (1.15) and effect of metabolic inhibitors — a small change in efflux — suggest that potassium efflux is a passive process. Stimulation (50/sec) did not give a large increase in the rate of either sodium or potassium efflux. The possible location of the radioactive isotopes in the lobster axon is discussed. Reasons are presented which suggest that these isotopes were in an active axonal compartment. A compartmental distribution of potassium within the axon is proposed. This compartmental system contains an intermediate compartment, which may be intracellular, with a higher concentration of potassium than the inner compartment which is intracellular. This model will allow a movement of potassium during the nerve impulse without a large increase in potassium efflux. This proposed potassium distribution could also explain specific differences which have been described between the lobster and squid axons. (Dissertation Abstr.)

Ecology

Refer also to abstract 19759.

20110 (COO-899-14) RADIATION AND OTHER FACTORS INFLUENCING THE DISTRIBUTION OF ANIMALS. Technical Progress Report, February 1966–January 1967. Breckenridge, Walter J.; Tester, John R. (Minnesota Univ., Minneapolis. Museum of Natural History). Contract AT(11-1)-899. 69p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on a study of the effects of various doses of γ radiation on the behavior and survival of frogs. Intensive field investigations were made of three toads, Bufo americanus, B. hemiophrys, and B. cognatus, in their natural habitats in northwestern Minnesota during all seasons of the year. Certain behavioral and survival aspects were studied in the laboratory under controlled conditions using both tadpoles and adult toads. Bufo americanus and B. cognatus adults, labeled with ^{182}Ta, were released in their respective habitats and tracked with portable scintillation detectors to their hibernation sites. Population dynamics were studied by trapping toads emerging from their overwintering sites. Results are reported from preliminary studies on the effects of γ radiation on behavior and survival. Survival of toads exposed to 1500 R immediately before hibernation was similar to that of control groups and was greater than that of groups that were active after irradiation. The behavior of toads exposed to 1500 R was similar to that of control groups. The $LD_{50/30}$ of adult Bufo hemiophrys was determined to be approximately 2097 R. (C.H.)

20111 (COO-1156-18) WILD DEER AS A SOURCE OF RADIONUCLIDE INTAKE BY HUMANS AND AS INDICATORS OF FALLOUT HAZARDS. Whicker, F. W.; Farris, G. C.; Dahl, A. H. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). Sept. 1966. Contract AT-(11-1)-1156. 19p. (CONF-660920-13). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy

Concentrations of various fallout radionuclides were measured in native forage and in tissues of wild mule deer over a five year period in north-central Colorado. Concentrations of ^{137}Cs in deer flesh were 5 to 13 times higher than concentrations reported in beef and in pork. The data indicated that consumption of deer flesh could result in a ^{137}Cs intake which could possibly exceed the intake of the nuclide from the total diet. Consumption of deer liver would result in the ingestion of ^{144}Ce, ^{137}Cs, ^{54}Mn, and ^{106}Ru. The data indicated that deer tissues can be useful and in some cases, unusually sensitive indicators of environmental contamination by ^{144}Ce, ^{137}Cs, ^{131}I, ^{54}Mn, ^{106}Ru, and ^{90}Sr. Relationships between forage and deer tissue for ^{137}Cs, ^{131}I, and ^{90}Sr were investigated. During 1963, the radiation dose to the skeleton of yearling deer from ^{90}Sr averaged 330 mrads, which was generally higher than the total dose from natural background and other sources combined. During the same period, the ^{90}Sr concentrations in deer bone were higher by a factor of 35 than reported bone levels in humans. During the study, dose rates to deer thyroid, liver, and muscle reached 20, 0.014, and 0.012 rads/year, respectively. (auth)

20112 (UCLA-12-612, pp 77-93) ENVIRONMENTAL RADIATION. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

The numbers of plants of different species in the Rock Valley (Nevada Test Site) study area were estimated. Seeds and leaves were quantitatively sampled. Stomach contents of rodents were examined to determine food preference. Radiosensitivity of certain plants from an area in which there was no evidence of damage other than damage from radiation was determined. The most sensitive species were the two sages, Artemisia arbuscula and A. tridentata. Two Mormon tea species, Ephedra spp., were somewhat less sensitive with three other species also being noted in the order of decreasing sensitivity: Grayia spinosa, Cowania mexicana, and the bunch grass Oryzopsis hymenoides, least sensitive of all. Ecological studies on the effects of radiation on arthropods were continued in the 20-acre test plots at Rock Valley (NTS). Seasonal variations in population density and behavioral patterns are the goals of the studies. Continuous recordings of soil surface temperatures and at six and nine inches below ground level and wind speed at the one foot level were made. The effects of these environmental factors on animal behavior activity patterns in hot desert areas are being determined. Techniques in marking prominent insect species, particularly the Coleopteran, Eleodes armata, were continued and a significant number of species that were marked in 1965 were recaptured during the spring, summer, and fall of 1966. Studies were also initiated to develop techniques in tagging small arthropods with fluorescent pigments. Intestinal tracts of lizards are being collected for determination of the role played by arthropods in desert food chains. Age-specific fertility and survival in female Uta lizards were worked out over a one-year period in a nonirradiated area of 2.8 acres. These data were combined and an overall estimate of the performance of the 1966 population was made. Results are presented in table form. Analyses of data on γ-irradiation of a Puerto Rican forest and its effects on lizards and frogs indicated that the radiation did not affect the animals beyond about 20 m from the radiation source. Surviving animals were not observed to have suffered deleterious effects. Acute γ-irradiation experiments with Uta stansburiana indicated that the $LD_{50,30}$ ranged from about 1700 to 2200 R. Adult males were more radiosensitive than females, but no sex difference was observed in animals 3 to 4 months of age. Methods for propagating shrubs from the NTS area were conducted. Specific responses of Atriplex confertifolia, Ephedra, Franseria, Grayia, Larrea divarcata, Lycium andersonni, and Lycium pallidum are described. Services performed by the Chemical Problems Section for the respective sections of the Environmental Radiation Division were outlined. Work performed by this group consisted mainly of determinations of radionuclide content in bone, fecal, milk, plant, and water samples. (B.H.S.)

20113 ^{90}Sr, ^{137}Cs, AND OTHER FALLOUT RADIONUCLIDES IN THE FOOD CHAIN OF A WHITE-TAILED DEER POPULATION IN THE GEORGIA PIEDMONT. Pullen, T. M. Jr.; Plummer, G. L.; Provost, E. E. (Univ. of Georgia, Athens). Bull. Ga. Acad. Sci., 25: No. 1, 26-42(Jan. 1967).

The occurrence of ^{90}Sr and certain gamma-emitting fallout radionuclides were investigated in a food chain involving the white-tailed deer in the Georgia Piedmont. Contamination levels of deer browse during the summer of 1965 were quite variable. Cesium-144, ^{106}Ru, ^{137}Cs, and ^{54}Mn were the most abundant gamma-emitting radionuclides present. Mean ^{90}Sr concentration in browse was about 55 pCi/g ash. Tissues obtained during November 1965, from male deer only were found to contain only ^{137}Cs and ^{90}Sr in detectable amounts. Cesium-137 was present in greatest concentrations in the tongue and in lowest concentrations in the liver. Mean ^{90}Sr concentration in mandibles was about 24 pCi/g ash. Significant correlation was found between the ^{137}Cs concentrations present in the tongue and those found in lung, kidney, and heart. (auth)

20114 SEASONAL VARIATION IN THE CONCENTRATION OF ^{137}Cs IN GRASS AND ALFALFA. Csupka, S.; Petrasova, M.; Carach, J. (Regional Station of Hygiene and Epidemiology, Bratislava). Nature, 213: 1204-6(Mar. 25, 1967).

The atmosphere-soil-plant relationships of ^{137}Cs are outlined. It is known that up to 70 to 80% of ^{137}Cs from fall-out is fixed and concentrated in the upper organic layer of the soil and remains there in an "unavailable" form, and uptake by the root systems of plants is small compared with uptake from direct contamination of other parts of plants. It was found that uncovered alfalfa showed 80% more activity than covered alfalfa. The radiocaesium content in vegetation varies throughout the whole vegetative period. Determinations were made of the content of this and other radionuclides in grass and alfalfa in Western Slovakia during 1962-65. Data are tabulated. Climatic factors such as rainfall and wind are discussed. The shape and size of the leaves also play an important part—alfalfa has a leaf area of 85.6 m^2/m^2 of soil, while for maize the figure is only 2.7 m^2/m^2. Data indicate that the activity in grass and alfalfa is higher in spring than in summer. On average, the activity was 20% higher in alfalfa than in grass. Results showed that variations in the content of ^{137}Cs in grass and alfalfa during 1962-65 depended mainly on the rate of fall-out in a given area, and such measurements provide a means of determining the rate of fall-out from nuclear weapon tests, provided climatic factors are taken into consideration. (UK)

20115 RADIOECOLOGY OF AQUATIC ORGANISMS. Polikarpov, G. G. New York, Reinhold Book Division, 1966. 340p. $16.50.

Translated from Radioekologiya Morskikh Organizmov.

The importance of marine radioecology in determining the effect of radiocontamination of sea water on the biological and commercial output of the sea, in predicting the risk to human health of radioactively contaminated marine food, and in working out measures for preventing radiocontamination of seas and oceans is discussed in the first part of the book. The accumulation of radioactive substances by marine organisms is considered in the second part of the book. Data on the concentration of radionuclides in each of the eight groups of elements in the periodic system are presented in each of eight chapters. Tables are presented giving concentration factors for radionuclides in the following organisms: diatoms, green algae, brown algae, red algae, protozoans, coelenterates, annelids, crustaceans, molluscs, echinoderms, fishes, amphibians, and aquatic birds. The role of aquatic organisms in migration of radioactive substances is also discussed. Data are included for both fresh-water and marine organisms. The effects of nuclear radiation on marine organisms are discussed in the third part of the book. Some topics included are: basic features of the biological effect of ionizing radiation; radioresistance; early manifestation of radiation injury in aquatic organisms; latent effects of various levels of radioactivity in an aqueous medium on the vital processes of aquatic organisms; effect of radioactive substances on populations and biocoenoses. General conclusions are discussed in the fourth part of the book. It is pointed out that almost every radionuclide is associated with several species of aquatic organisms that function as biological concentrators. Strontium-90 accumulated during life is returned to the environment from dead marine plants; ^{90}Sr is, therefore, not only more hazardous to man than other radionuclides in food, but is also more mobile in the sea. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstracts 20056, 20211, 20340, 20431, 20434, and 20445.

20116 (COO-1609-1) GENETIC STUDIES ON SOMATIC CELLS OF THE HIGHER PLANT, ARABIDOPSIS. Progress Report No. 1, May 1–December 31, 1966. Redei, Gyorgy Pal (Missouri Univ., Columbia). Contract AT(11-1)-1609. 52p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A mutant designated im was obtained by x irradiation of presoaked seeds of the Columbia wild type of Arabidopsis thaliana. The recessive mutant im in homozygous condition displayed variegation. In certain cells plastid differentiation was arrested, while in others the chloroplasts were apparently normal. Plastid development within the cell was uniform. Prevailing epigenetic factors determined the transition from one state of differentiation to the other. Sectoring was not found in heterozygotes. Hence, high somatic mutability was ruled out. Since the mutant cells displayed a facultative ability to produce normal chloroplasts, the genetic alteration did not directly effect any of the structural genes. Mutation in a regulator gene was eliminated by definition, and direct evidence for the existence of an operator site was not available. White tissues of the mutant accumulated inorganic phosphorus, but Ca and Mg contents of the types of cells were the same. When the mutant was grown on 6-azauridine- or 6-azacytidine-containing media, the variegation was suppressed, and normal green phenotype was more-or-less restored. Kinetin had a similar effect. Kinetin is a regulator of RNA metabolism, and evidence is presented that excessive RNAase activity existed in the white tissues of the mutant. Further, it was shown that although Arabidopsis possesses three ribonucleases, only an acid ribonuclease was overproduced in the mutant. Results implied that the im locus played an important role in the control of the acid RNAase. Possible mechanisms of control are discussed. (H.G.D.)

20117 (NP-16482) ANNUAL REPORT OF THE NATIONAL INSTITUTE OF GENETICS, NO. 16, 1965. (National Inst. of Genetics, Mishima (Japan)). 1966. 148p. Dep. mn.

Progress is reported in studies on genetics, cytology, and biochemistry of Drosophila, mice, rats, and other animals; studies on genetics, cytology, and biochemistry of wheat, rice, tobacco, morning glories, and maize are also reported. Studies on mathematical analyses of genetic variability in quantitative characters, and studies on genetics and biochemistry of microorganisms are

reported. Radiation genetics studies include the following: mechanisms underlying the enhancing effect of induced-mutation frequency after fractionated γ irradiation of silkworm gonia; time of reversal of radiation dose-rate effect on mutation induction in silkworm gonia; post-irradiation treatment of silkworm spermatogonia with various metabolic inhibitors; proliferation kinetics of silkworm spermatogonia during chronic γ irradiations; change in distribution of primary spermatogonia of the silkworm at various phases of the cell cycle after irradiation; radiosensitivity of silkworm spermatogonia during the cell cycle; variation in radiosensitivity during the early developmental stage of the silkworm egg; enhancing effect of fractionated irradiation with 14-MeV neutrons on the induction of visible recessive mutations in silkworm gonia; chromosome aberrations induced in mouse bone marrow cells by γ irradiation; persistent chromosome aberrations in mouse bone marrow cells after γ irradiation; photoreactivation of uv-induced mutation in maize pollen; effects of dose fractionation of γ rays on mutation in maize pollen; storage and oxygen effects on γ induced mutation in einkorn wheat; genetic effects of x-irradiated pollen in wheats; relation between polyploidy and radiosensitivity; development of mutated cells in diploid wheat; effects of uv rays on Arabidopsis thaliana; and mutagenic efficiency of heavy ionizing particles in Arabidopsis thaliana. Progress is reported in studies on identification of human somatic chromosomes and other studies in human genetics. (H.L.W.)

20118 (NYO-2467-17) GENETIC AND DIRECT EFFECTS OF GAMMA RADIATION ON DROSOPHILA. Final Report. (Amherst Coll., Mass. Dept. of Biology). Sept. 30, 1966. Contract AT(30-1)-2467. 5p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of studies on the pattern of mutagenesis displayed in successive stage of spermatogenesis in Drosophila melanogaster following acute doses of γ radiation are reported. It was shown that when conditions are properly controlled, the peak rate of induced translocations in males raised at 18°C, which doubles the length of time needed to complete development compared to 25°C, hits a peak in the 10 to 12 day sample of sperm instead of in days 5 and 6 that characterizes those males raised at 25°C. Thus the production of chromosomal observations shows the same change in pattern as does the production of point mutations when developmental temperature is lowered to 18°C. It is concluded that the rate of mutational effect depends upon the state of spermatogenesis at which the radiation enters the gonads. Comparative mutagenic rates in sperm deposited in the first mating after irradiation and in those sperm deposited in subsequent matings during the first day after irradiation were investigated. At 1 kR doses of γ or hard x rays, point mutations (X-linked lethals) were induced at equal frequencies in both types of sperm, but chromosome rearrangements (autosomal and Y-chromosome translocations) were produced almost twice as frequently in the former type. Observations on the ecology of natural and man-associated populations of Drosophila in the Amherst, Massachusetts, area indicated that native species of the genus overwinter in the larval stage, in a diapause condition in favorable mulch situations where insulation prevents freezing; and that there is a large emergent adult population within a few days after ground temperatures reach about 12°C in the sping or early summer. Preliminary studies of allelism of lethal chromosomes extracted from the local natural population are reported. (H.G.D.)

20119 (ORO-2975-3) A STUDY OF GENETIC VARIANCE AND COVARIANCE IN A NATURAL BREEDING POPULAION OF PEROMYSCUS POLIONOTUS AND THE EFFECT OF RADIATION ON THESE GENETIC PARAMETERS. Progress Report, May 1, 1966–Februuary 1, 1967. (Georgia Univ., Athens). Feb. 1, 1967. Contract AT(40-1)-2975. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A progress report is presented on the effects of the interaction of radiation with other factors on various fitness traits of old-field mice (Peromyscus polionotus). Males maintained at 3 different temperature levels (60, 75, and 90°F) were treated with 0, 100, and 200 R doses of gamma radiation. The offspring of the mating of these males with untreated females were measured for growth rates and litter sizes. Temperatures of 75°F and radiation doses of 200 R result in the fastest growth rates. The lower the temperature within the range studied the larger the litter size, and the 100 R radiation doses were optima for large litter size. The interaction of temperature and x radiation was also studied. Mice maintained at the 3 temperatures were irradiated with 1000, 1100, 1200, and 1300 R whole-body irradiation using a cobalt-60 source. The $LD_{30/30}$'s for males and females which received these different treatments are reported. The effect of pairing was measured by irradiation of mice maintained singly or as bisexual pairs with 900, 1100, or 1300 R from a cesium source. It was tentatively concluded that pairing slightly increased the number of animals that died from radiation damage. (M.M.B.)

20120 (RM-5096-TAB) THE GENETIC EFFECTS OF RADIATION: POSTATTACK CONSEQUENCES. Arnheim, Norman Jr. (RAND Corp., Santa Monica, Calif.). Nov. 1966. Contract AT(04-3)-414. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experimental irradiation of animal populations has demonstrated the production of genetic damage by ionizing radiation. The total dose received, the dose rate, and the type of cell treated have been found to affect the frequency of mutation. Recent studies suggest that the prevention of conception for a period after radiation exposure can reduce genetic damage. Human populations which have been subjected to radiation also suffer genetic damage, although the statistical demonstration of abnormalities in the offspring of exposed individuals is extremely difficult considering the doses received and the number of people available for study. Gene mutations produced by radiation exposure will burden human populations for many generations. The exact nature of this burden in physical and psychological terms cannot, however, be fully assessed at this time. (auth)

20121 CHROMOSOME ARRANGEMENT AND RADIOINDUCED CHROMATID ABERRATIONS IN BELLEVALIA ROMANA. Glaess, E.; Marquardt, H. (Univ., Freiburg i. B.). Int. J. Radiat. Biol., 11: 145-51(1966). (In German).

The chromosomes of Bellevalia romana ($2n = 8$) are randomly distributed in mitotic metaphases of untreated and x-irradiated (300 R) root-tip cells. Pairing of homologous chromosomes is a rare event and so chromatid translocations between homologous chromosomes are infrequent. Translocations occur preferentially in the centromeres and in the long arms of chromosomes. Short arms are free of translocations. In chromosome A, the shorter arm was involved in only 3 of 75 translocations; they are less frequent in the median and distal regions of the chromosomes. Translocation breaks in the same or neighboring regions recombine more frequently than in distant regions. The following factors in chromatid translocations are discussed: the arrangement of chromosomes in the nucleus relative to each other; the proximity of centromeres and adjacent zones by the anaphase movement; and the length of chromosome arms determining the mechanical tension. Heterochromatin is too rare in Bellevalia to influence recombination. (auth)

20122 EFFECT OF URETHANE AND COLCHICINE ON RADIATION-INDUCED CHROMOSOME LOSS IN MALE DROSOPHILA. Mittler, Sidney; Arnesen, James F.; U, Raymond (Northern Illinois Univ., DeKalb). Int. J. Radiat. Biol., 11: 161-70 (1966).

Urethane or colchicine was injected, either before or immediately after 2000 R of x rays, into male Drosophila melanogaster. Urethane modified the radiation-induced loss of the ring X or Y $sc^8 y^+$ chromosome, as determined by the number of XO male offspring. Urethane alone increased the loss of the ring X chromosome primarily in the mature spermatozoa and older spermatids, whereas x rays induced chromosome loss to a greater extent in those cells in or about meiosis. Pre-treatment or post-treatment with colchicine by means of injection near the testis gave an apparent protection against radiation-induced chromosome loss; but colchicine alone induced sterility by reducing the number of gametes available to form zygotes by affecting those cells in spermatogenesis that were in or about meiosis at the time of treatment. (auth)

20123 DIFFERENTIAL EFFECTS OF ACRIFLAVINE AND CAFFEINE ON VARIOUS ULTRAVIOLET-IRRADIATED ESCHERICHIA COLI STRAINS AND TI PHAGE. Harm, Walter (Southwest Center for Advanced Studies, Dallas, Tex.). Mutat. Res., 4: 93-110(Mar.-Apr. 1967).

Caffeine and acriflavine are known to inhibit repair of uv lesions in DNA of host-cell-reactivating [HCR(+)] Escherichia coli strains. Large differences were observed between various strains: B, B/r(λ), and K12(λ), carrying extra uv sensitivity relative to B/r and K12S, respectively, show much greater repair inhibition than the latter strains. This seems to be related to the (normally) rather incomplete repair in B, B/r(λ) and K12(λ), which was inferred from results on liquid-holding recovery. Both incompleteness of repair and its great susceptibility to inhibition by caffeine or acriflavine could be explained by the assumption that uv lesions related to the extra sensitivity require the repair early. This assumption seems plausible at least for the extra sensitivity resulting from lysogenicity. Decreased uv survival in the presence of acriflavine or caffeine was also found in HCR(−) strains. B_{s-1}, and B syn^-, differing considerably in their uv sensitivities, show equal survival (at levels between 1 and 10^{-4}) if incubated with 7.5 μg/ml acriflavine. The possible interpretation that all HCR(−) strains tested exhibit residual repair activity in the absence of acriflavine or caffeine, is supported by the finding that HCR(−) strains also show a slight residual HCR activity, inhibitable by acriflavine or caffeine, toward uv-irradiated phage

T1. However, part of the decreased cell survival might be due to synergistic effects between uv and acriflavine. At the highest applicable concentration, acriflavine is a stronger repair inhibitor than caffeine. However, neither substance decreases uv survival of HCR(+) cells or phage infecting HCR(+) cells to the level to which survival of HCR(−) cells or phage infecting HCR(−) cells is decreased by acriflavine or caffeine. (auth)

20124 TWO TYPES OF RADIATION-SENSITIVE MUTANT IN YEAST. Nakai, Sayaka; Matsumoto, Shinji (National Inst. for Radiological Sciences, Chiba, Japan). Mutat. Res., 4: 129-36(Mar.-Apr. 1967).

Three radiosensitive mutants designated UV^s_1, UV^s_2, and X^s_1 were isolated from the yeast Saccharomyces cerevisiae. The three genes responsible for radiation sensitivity are located at different loci. In haploid states, the single mutants, X^s_1, UV^s_1, and UV^s_2, the double mutants, UV^s_1 UV^s_2, X^s_1 UV^s_1, and X^s_1 UV^s_2, and the triple mutant, X^s_1 UV^s_1 UV^s_2, have, respectively, 1.5, 27, 27, 27, 80, 60, and 80 times higher sensitivities to killing by ultraviolet (2537 Å) irradiation than the wild-type strain. In diploid states, homozygous mutants, X^s_1/X^s_1, UV^s_1/UV^s_1, and UV^s_2/UV^s_2, and heterozygous mutants, $X^s_1/+$, $UV^s_1/+$, $UV^s_2/+$, have, respectively, 2, 28, 28, 1.5, 1, and 1.5 times higher sensitivities to uv-killing than the wild-type. With regard to X-ray sensitivity, mutant genes, UV^s_1 and UV^s_2, have no effect but the X^s_1 gene has an appreciable and interesting effect. The sensitization effect of the X^s_1 gene is unique: it eliminates the tailing effect typical in wild-type haploid survival curves, and the shoulder in the wild-type diploid survival curves. Experimental results indicate that a similarity exists between the UV^s gene in yeast and the uv-sensitive genes giving rise to reduced dark repair ability in E. coli and between the X^s gene in yeast and Rec^- gene in E. coli. (auth)

20125 INDUCTION OF HIGH-YIELDING MUTANTS IN JUTE. Basu, Rabindra Krishna (Bose Inst., Calcutta). Mutat. Res., 4: 163-7(Mar.-Apr. 1967).

Repeated selection of tall and thick-stemmed plants made in a number of generations after treatment with x rays and ^{32}P on jute seeds led to the isolation of 4 high-fibre-yielding mutants, 2 each in Corchorus olitorius and C. capsularis. The capsularis mutants had an unusual combination of characters of early-flowering and short-flowering period. Evidence is presented to indicate that high-fibre yield of an x-ray-induced mutant, Tall Mutant, over the mother line R. Twenty-six in C. olitorius is mainly due to increased number of ultimate fiber cells. (auth)

20126 THE OXYGEN EFFECT AND ITS RELATION TO CHANGES IN RADIOSENSITIVITY DURING SEED GERMINATION. Latterell, Richard L.; Steffensen, Dale M. (Smithsonian Institution, Washington, D. C. Univ. of Illinois, Urbana). Mutat. Res., 4: 191-200(Mar.-Apr. 1967).

The relation of enhancement of x-ray-induced lesions by oxygen to changes in radiosensitivity during seed germination was investigated by means of somatic mutation techniques. Paired samples of maize seeds heterozygous for alleles, Yg_2/yg_2, were irradiated in air or helium after having been presoaked at 27° for varying periods of time up to 26 hr. Frequencies of yellow-green sectors of leaf tissue, which arise from chromosome breakage and loss of the dominant allele, were the criterion of response to radiation. Dry seeds and seeds presoaked for less than 3 hr showed comparable levels of sensitivity to x rays whether irradiated in air or in helium. Samples presoaked 4 to 5 hr or longer showed a marked and progressive increase in yields of somatic mutations when irradiated in air. The initial rise in sensitivity in the helium series did not appear until after 8 to 10 hr presoaking. Both series underwent an approximately 5-fold increase in radiosensitivity between 16 and 26 hr. The ratio of somatic mutations induced in the presence of oxygen to those induced in anoxia was 1.2 for dry seeds and seeds soaked up to 3 hr. Between 3 and 6 hr the ratio rose to 2.4 and remained relatively constant thereafter. Pretreatment with, and irradiation in, pure oxygen, even under pressure, failed to modify either the time of inception or the magnitude of oxygen effects. (auth)

20127 DOSE-RATE EFFECT IN THE REPAIR OF RADIATION DAMAGE IN SPERMATIDS OF DROSOPHILA MELANOGASTER. Sankaranarayanan, K. (Univ. of Leiden. Inst. for Radiopathology and Radiation Protection, Leiden). Mutat. Res., 4: 222-4 (Mar.-Apr. 1967).

Mutation frequency was studied in Drosophila melanogaster males exposed to low dose-rates of x radiation under conditions of anoxia and followed by treatment with either nitrogen or oxygen. Frequencies of sex-linked lethals were not significantly different in the nitrogen and the oxygen post-treated groups. Following irradiation, neither gas was effective in bringing about repair. (H.G.D.)

20128 THE REVERSED DOSE-RATE EFFECT WITH FAST NEUTRON IRRADIATION OF MOUSE SPERMATOGONIA. Batchelor, A. L.; Phillips, Rita J. S.; Searle, A. G. (Medical Research Council, Harwell, Eng.). Mutat. Res., 4: 229-31(Mar.-Apr. 1967).

The mutational yield following a high acute exposure to fast neutrons was compared with that after a fairly low chronic exposure in mouse spermatogonia. Chronic irradiation was much more effective for induction of specific locus mutations and dominant visible mutations. Data from this and previous experiments agree with the hypothesis that the mutation frequencies are linearly related to dose with chronic neutron irradiation. Results suggest that the generally high genetic effectiveness of fast neutrons in mice is not the result of germinal selection. However, the rate of induction of specific locus mutations with 62 rad was about 40% higher per rad than the 214-rad chronic neutron irradiation, although the divergence from linearity was not significant. Therefore, the possibility remains that germinal selection may tend to increase the yield at low doses through the survival of a higher proportion of those germ cells that were irradiated at a genetically radiosensitive stage. (H.G.D.)

20129 RATE OF DOMINANT LETHALS AFTER LOW X-RAY DOSES GIVEN TO MOUSE SPERMATOZOA. Leonard, A.; Deknudt, Gh. (Centre for Nuclear Energy Research, Mol, Belg.). Mutat. Res., 4: 234-6(Mar.-Apr. 1967).

Studies on the relation between x-ray dose and the rate of dominant lethals induced by irradiation of mouse spermatozoa are reported for doses from 10 to 100 R. Male mice from the BALB/c strain received whole-body irradiation with doses of 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 R. Immediately after treatment, each male was allowed to mate with three virgin females for a period of seven days. Results showed that a low x-ray dose given to mouse spermatozoa increased the rate of intrauterine deaths. The number of dead embryos per female increased regularly from 10 to 100 R. The rate of dominant lethal mutations following such doses was slightly higher than expected, since the regression coefficient was found to be $b = 0.001142$. (H.G.D.)

20130 NON-PHOTOREACTIVATING REPAIR OF MUTATIONAL LESIONS INDUCED BY ULTRAVIOLET AND IONIZING RADIATIONS IN ESCHERICHIA COLI. Munson, R. J.; Bridges, Bryn A. (Medical Research Council, Harwell, Eng.). Mutat. Res., 3: 461-9(Dec. 1966).

The action of one established and two presumed repair systems on premutational lesions induced by ionizing and ultraviolet radiations has been studied in the tryptophan auxotrophs Escherichia coli B/r WP2 and E. coli WP2 hcr^- (which has a reduced ability to excise thymine dimers). Premutational lesions induced by ionizing radiation are not susceptible to excision-repair nor to the mutation-frequency decline which occurs with uv lesions in minimal media, but are removed by a slow-acting process at 16°. Premutational lesions induced by uv are removed by excision-repair, by mutation-frequency decline, both at 37° in minimal medium and at 16° even on plates enriched with nutrient broth, and by a similar low-temperature process to that which acts at 16° on lesions induced by ionizing radiation. There is some evidence that mutation-frequency decline may be related to excision-repair, for example by the involvement of a common enzyme. Alternatively mutation-frequency decline could merely reflect the excision-repair of premutational lesions which are more amenable to excision than thymine dimers. The slow acting process at 16° appears to be quite distinct from excision-repair and mutation-frequency decline since, unlike these, it occurs normally in WP2 hcr^-. (auth)

20131 CYTOLOGICAL EVALUATION OF DOSE-RATE EFFECTS OF RADIATION ON MUTATION FREQUENCY OF SILKWORM GONIA. I. KINETICS OF PROLIFERATION AND KILLING OF SPERMATOGONIA DURING CHRONIC IRRADIATION. Sado, Toshihiko (National Inst. of Genetics, Misima, Japan). Mutat. Res., 3: 510-21(Dec. 1966).

The kinetics of proliferation and killing of spermatogonia of young silkworm larvae during chronic irradiation (^{60}Co or ^{137}Cs γ-rays, 0.126 or 0.130 R/min for 5 days; total dose, 900 R) was studied. The following kinetic indices were determined at various intervals after the onset of the exposure: total viable cell (or gonocyst) counts, incidence of pycnosis, mitotic index, and labeling index, or the percentage of cells that take up [^3H]thymidine in 1 hr after isotope administration. The results confirm and extend our earlier findings. The majority of secondary spermatogonia were killed during chronic irradiation, and only a few of them (12 cysts per testis) survived the exposure when the larvae were irradiated between 5 and 10 days after hatching. With regard to the primary spermatogonia, there was a considerable suppression of mitosis as well as a block of cells in G_1 entering the S phase during the early intervals after the onset of the chronic exposure starting on day 5 after hatching. This indicates that the distribution of cells at various phases of the cell cycle during chronic irradiation was significantly different from that of unirradiated cell populations

to which a single acute dose is generally given to compare the dose-rate effect on mutation induction. The radiosensitivity of spermatogonia (both primary and secondary) varied, depending upon the developmental stage of the larvae. The earlier the larvae were exposed to chronic irradiation, the less sensitive were the spermatogonia to radiation killing and mitotic inhibition. The significance of these findings to the mechanism of dose-rate effect on mutation frequency in silkworm gonia is discussed. (auth)

20132 RADIATION-INDUCED NON-DISJUNCTION AND LOSS OF CHROMOSOMES IN DROSOPHILA MELANOGASTER FEMALES. II. EFFECTS OF EXCHANGE AND STRUCTURAL HETEROZYGOSITY. Day, J. W.; Grell, R. F. (Oak Ridge National Lab., Tenn.). Mutat. Res., 3: 503-9(Dec. 1966). (ORNL-P-2043).

The role of exchange and structural heterozygosity in radiation-induced nondisjunction and loss in the oöcyte of Drosophila melanogaster has been investigated by irradiating 2 types of females, one heterozygous and the other homozygous for a multiply inverted X-chromosome. The frequencies of exchange tetrads in the oöcytes of the two genotypes were estimated as ~24% for the heterozygote and ~90% for the homozygote. An examination of the first 7 daily broods from both kinds of females irradiated with 4000 R of x-rays revealed no significant difference in X-chromosome loss or nondisjunction between the 2 genotypes. The average non-disjunction frequencies for the entire period were 1.57 ± 0.19% for the homozygotes and 1.74 ± 0.24% for the heterozygotes. The corresponding frequencies of loss were 5.21 ± 0.37% and 7.19 ± 0.67%. The values obtained for stage 8–14 oöcytes from homozygous and heterozygous females irradiated with 500 R were 0.22 ± 0.21% and 0.33 ± 0.18%, respectively, for non-disjunction, and 2.46 ± 0.33% and 2.57 ± 0.33%, respectively, for loss. The results indicate that neither structural heterozygosity of homologs nor exchange between homologs modifies the frequencies with which they non-disjoin or are lost following irradiation of the oöcyte. (auth)

20133 RADIATION-INDUCED NON-DISJUNCTION AND LOSS OF CHROMOSOMES IN DROSOPHILA MELANOGASTER FEMALES. I. THE EFFECT OF CHROMOSOME SIZE. Grell, R. F. (Oak Ridge National Lab., Tenn.); Munoz, E. R.; Kirschbaum, W. F. Mutat. Res., 3: 494-502(Dec. 1966). (ORNL-P-2013).

The role of chromosome size in radiation-induced non-disjunction and loss in Drosophila melanogaster has been investigated by irradiating newly eclosed females carrying 2 extra small chromosomes of equivalent length, one a free four and the other a free X duplication. In the unirradiated controls the extra chromosomes segregate from one another ~99.9% of the time and show no loss. After irradiating the mothers with 4000 R of x radiation, the average non-disjunction frequency of the 2 small chromosomes, as measured in the first 12 daily broods, was 1.24 ± 0.07%. This value is not significantly different from the 1.19 ± 0.15% obtained for the large X-chromosomes for the same period despite a 10-fold difference in chromosome length. The result indicates that radiation-induced non-disjunction is unrelated to chromosome length. A comparison of the frequency of loss for the large and small chromosomes discloses that in the oöcyte the X-chromosomes are lost about 3 times as often as the duplication and the four (5.82 ± 0.20% and 1.95 ± 0.10%, respectively). There is a marked stage sensitivity in the oöcyte, with a maximum loss for both the large and small chromosomes occurring in the first or second brood and lower frequencies occurring in later broods. The results are compatible with the hypotheses that events at the centromere or adjacent regions, incident to radiation, are responsible for non-disjunction and that radiation-induced sister-chromatid dicentric formation contributes to chromosome loss. (auth)

20134 RADIATION-INDUCED GENETIC MOSAICISM AND LETHAL SECTORING IN YEAST. James, A. P.; Werner, M. M. (Chalk River Nuclear Labs., Ont.). Mutat. Res., 3: 477-85 (Dec. 1966).

The induction of mosaics for recessive lethal mutations by x rays was studied in a diploid strain of Saccharomyces cerevisiae. Mosaicism was detected by genetic analysis (frequencies of live and dead spores within asci) of individual third generation vegetative lines of descent from irradiated cells. Only about 30% of radiation-induced mutants were mosaic, and most if not all of this mosaicism was exposed at the first post-irradiation cell division. It was concluded that the genetic effects of x rays usually appear as lesions in both original strands of DNA as well as in both newly replicated strands. Lethal sectoring, the presence of sub-clones of dead cells, was common in the early generations of macro-colonies developing from x-irradiated cells. No evidence could be found that this mosaicism for dominant lethality was genetic in origin. However, the frequency of recessive lethals was higher among sectored colonies. It was demonstrated that lethal sectoring grossly distorts the estimate of genetic mosaicism as inferred from the relative frequencies of mosaic and wholly mutant colonies. (auth)

20135 CYTOLOGICAL EVALUATION OF DOSE-RATE EFFECTS OF RADIATION ON MUTATION FREQUENCY OF SILKWORM GONIA. II. EVIDENCE OF G_2 ACCUMULATION OF PRIMARY SPERMATOGONIA AFTER IRRADIATION. Sado, Toshihiko; Oishi, Kugao (National Inst. of Genetics, Misima, Japan). Mutat. Res., 3: 522-36(Dec. 1966).

The effects of acute irradiation on the kinetic indices of primary spermatogonia of the silkworm have been studied in an attempt to gain cytological insight into the mechanisms of dose-fractionation effects on the induction of mutation. Kinetic studies, with the use of colchicine treatment and the [^{3}H]thymidine-labeling technique, on primary spermatogonial populations in unirradiated larvae showed that primary spermatogonia of this insect had a mean generation time of 34 h, of which the relative time occupied by the various phases of cell cycle was roughly as follows: G_1, ~40%; S, ~40%; G_2, ~18%; and M, ~2%. Cytokinetic studies on the effect of acute irradiation (1000 R) on the population of primary spermatogonia showed that during the first 24 h after irradiation the relative frequency of cells in different phases of the cell cycle changed noticeably. Thus, at 24 h as many as 58% of the total population was shown to be in the G_2 population in contrast to 18% of the unirradiated primary spermatogonial population. Furthermore, only 3%, instead of 40%, in the control, was in the S phase at this time. It is tentatively concluded that enhanced mutation frequency in dose-fractionation experiments was primarily due to an increase in the relative frequency of cells in the G_2 population. However, the possibility remains that accumulation of cells in late G_1 might also be responsible for the enhancement of mutation frequency by dose fractionations. (auth)

20136 CAUSES OF VARIEGATED INHERITANCE OF RECESSIVE SEX-LINKED LETHAL MUTATIONS IN DROSOPHILA MELANOGASTER. Glembotskii, Ya. L.; Abeleva, E. A.; Grozdova, T. Ya.; Myasnyankina, E. N. (Inst. of General Genetics, Moscow). Genetika, No. 3, 68-75(Mar. 1967). (In Russian).

The appearance of F_1 individuals, in which only a part of their body bears a mutation, following the treatment with chemical mutagens or radiation, is usually explained as the results of multistranded chromosome structure in mature spermatozoa. Since it was already shown earlier that the mutations can take place in the non-irradiated chromosomes of the ovules fertilized by the irradiated male germ-cells, an assumption was made that the occurrence of partial mutants can be accounted for by the action on the chromosomes of cells, during the first stages of the zygote cleavage, of the mutagenic agent formed as the result of the irradiation and introduced by the spermatozoön. This hypothesis also apparently explains the low frequency of the detection of such mosaic individuals and the relatively high efficiency of chemical mutagens. In these studies the frequencies of chromosome and chromatid sex-linked lethals and sublethals were determined both in the directly irradiated chromosomes of males (doses of 1000 and 1500 R of X-rays and gamma-rays) and in the chromosomes of eggs that had not been irradiated but had been fertilized by irradiated male gametes (dose 1500 R of gamma-rays). It was established that the frequencies of chromatid mutations in the directly irradiated chromosomes are 5 to 6 times as high as those in the non-irradiated chromosomes. No chromatid lethals were ever found in the nonirradiated chromosomes. Therefore the appearance of partial mutants can be associated with the delayed effect of irradiation to but an insignificant extent. (auth)

20137 NATURE OF INDUCED MUTATIONS IN HIGHER PLANTS. Nilan, R. A. (Washington State Univ., Pullman). Genetika, No. 3, 3-22(Mar. 1967). (In Russian).

The article is a review of investigations on induced mutations in higher plants. The resolving power of the investigations is sufficient for distinguishing induced mutations in higher plants at and even within a single locus, but insufficient for detection of discrete changes in DNA and relating these changes to the mutations, both spontaneous and induced. The reasons for slow accumulation of knowledge about the nature of induced mutations are considered. Explanations are proposed for the recessive nature and pleitropism of induced mutations. The viewpoint is discussed, according to which most spontaneous mutations are intragenic, while most, if not all, of the induced mutations are extragenic. Types of extragenic mutations are considered, including the unequal or oblique crossing over, intrachromosomal crossing over, variegation position effects caused by chromosome rearrangements, mutations caused by gene controlling elements, paramutation, deficiencies and duplications, specific chromosome rearrangements, unspecified chromosomal aberrations, extrachromosomal mutations and changes in chimera relations. It is pointed out that uv light and chemical mutagens induce a relatively higher proportion of intragenic mutations, whereas a higher proportion of extragenic mutations is characteristic of ionizing radiation. The importance of the genes whose phenotypes are expressed in the gametophytic

stage for the investigation of intragenic mutations is emphasized, as well as the significance of allelic complementation and recombination studies and of biochemical studies of gene action at specific loci. Investigations on the problem of the alteration of mutation spectrum and mutagen specificity are critically reviewed, particular attention being paid to the factors distorting the results of the experiments and the erroneous conclusions if these factors are not taken into consideration. The problem of interlocus specificity in plants is discussed. A conclusion is drawn that apparently different mutagens and different treatment conditions can induce some changes in mutation spectra in higher plants, although more refined experimentation at specific loci is necessary for the further progress in this. (122 references.) (auth)

20138 VALUABLE MUTANTS IN IRRADIATED BARLEY. Preeatchenkoo, A.; Greenvald, K. (Research Inst. of Cereals and Industrial Plants, Bucharest). Genetika, No. 3, 49-54(Mar. 1967). (In Russian).

The use of thermal neutrons for the induction of mutations in winter barley proved to be a convenient method to obtain plants with one or more economically valuable characters. The detection of mutations was more rapid in N_3 after first individual selections. It was only by means of repeated selection during several years that lines were obtained possessing the valuable characters that had been induced by irradiation. These lines retained their constancy during four of five years. (auth)

20139 SELECTION OF MICROCOCCUS GLUTAMICUS, A GLUTAMIC ACID-PRODUCING MICROORGANISM AND THE STUDY OF PHYSIOLOGICAL CHARACTERS OF ITS MUTANTS. Zhdanova, N. I.; Balitskaya, R. M.; Alikhanyan, S. I. (Inst. of Atomic Energy, Moscow). Genetika, No. 3, 122-9(Mar. 1967). (In Russian).

Strains of Micrococcus glutamicus exceeding in their productivity the initial strain ATCC-13032 were selected after the treatment with uv and diethylsulfate vapour. The mutants differ from the initial strain in pigmentation, in the ureatic activity and in the growth-rate during fermentation. All the mutants have an increased capacity for glutamic acid production in the media with a biotin content two to three times as high as that for the initial strain. The biosynthesis of glutamic acid in some mutant strains is less dependent on the aeration than it is in the initial strain. (auth)

20140 EFFECT OF DIFFERENT MUTAGENS ON THE FREQUENCY OF ACTINOMYCES AUREOFACIENS MUTANTS SYNTHESIZING TETRACYCLINE DERIVATIVES. Gol'dat, S. Yu.; Makarevich, V. G.; Laznikova, T. N. (All-Union Research Inst. of Antibiotics, Moscow). Genetika, No. 3, 130-5(Mar. 1967). (In Russian).

Actinomyces aureofaciens spores were treated with nitrosomethylurea and hydrogen peroxide and its combinations with uv and x rays. The mutants obtained differed from the initial strain in their morphology and the capability of synthesizing the products differing from tetracycline. No specific effect of the mutagens used on the induction of mutations was observed. Only morphological mutants were isolated from the colonies of natural platings. (auth)

20141 CHROMOSOME-EXCHANGE ABERRATIONS IN HUMAN LYMPHOCYTES. Norman, Amos; Sasaki, M. S. (Univ. of California, Los Angeles). Contract AF 41(609)-2944. Int. J. Radiat. Biol., 11: 321-8(1966).

The probability of finding a given chromosome in a dicentric is directly proportional to the length of that chromosome at interphase, but not to the length of the early replicating portion of the interphase chromosome or to its length at metaphase. The number of dicentric chromosomes and centric rings per cell is limited primarily by the number of centromeres. These results are consistent with the assumption that every chromosome break is a site for chromosome-exchange. (auth)

20142 INDUCTION OF DESIRABLE CHARACTERS IN WHEAT BY RADIATION. Singh, M. P. (Indian Agricultural Research Inst., New Delhi). Indian J. Exp. Biol., 4: 234-6(Oct. 1966).

Dry seeds of three wheat varieties, viz. NP 829, Ridley and NP 770, have been exposed to different dosages of x rays (16000 and 21000 R), gamma rays (16000 rads), fast neutrons (10^9nf/cm^2/sec) and radioisotopes ^{32}P and ^{35}S (5 μCi/seed), to induce awning in the tipped varieties of Ridley and NP 829 and to suppress awning and tough glumes in NP 770. Some fully bearded mutants in Ridley and NP 829 and awnless mutants in NP 770 and NP 829 were isolated in M_2. Promising selections have been separated in M_2 and their further breeding potentialities evaluated in M_4. Awned mutations occur readily in tipped varieties with a single gene (B_1 in chromosome 5A in Ridley and NP 829) epistatic mechanism. The results show that certain defects of improved varieties can be eliminated or some desirable characters can be added through continuous mutation breeding, if the desirable character is conditioned by one or two genes. (auth)

20143 I. GENETIC STUDIES OF IRRADIATED NATURAL POPULATIONS OF DROSOPHILA. V. SUMMARY AND DISCUSSION OF TESTS OF POPULATIONS COLLECTED IN THE PACIFIC PROVING GROUND FROM 1955 THROUGH 1959. Stone, Wilson S.; Wheeler, Marshall R.; Wilson, Florence D. (Univ. of Texas, Austin). Tex., Univ., Publ., No. 6205: 54p(1962).

A study of the effects of fallout radiation and other factors on Drosophila ananassae populations that were collected in July and August for a five-year period (1955-1959) from islands in the Pacific Proving Ground area was made. Two islands that received little fallout as compared to that received by Rongelap Island and Bikini Island from thermonuclear devices exploded nearby served as control areas. Samples of populations from low and high level fallout zones were tested and compared in terms of viability, fertility, and fecundity each year. Some populations were examined for kinds and frequencies of visible mutants; these were then compared to similar test results with other species of Drosophila. (TSS)

20144 RESULTS OF MEIOTIC ANALYSES OF VIABLE MUTANTS OF DURUM WHEAT INDUCED BY PHYSICAL AND CHEMICAL MUTAGENS. Martini, G. (Univ., Pisa, Italy). Caryologia, 19: 241-54(1966). (In Italian).

An analysis was made of microsporogenesis of 141 radioinduced mutant progenies of Triticum durum of the Cappelli variety, representing 88 M_1 individuals (51 M_3 and 90 M_4 progenies) and of 29 M_4 mutant progenies of tha Aziziah variety (originating from 7 M_1 plants). All progenies were derived from seed treated with physical (x rays, thermal or fast neutrons) or chemical (ethylmethane sulfonate, diethyl sulfate or ethyleneimine) mutagenic agents. Morphological and pigmental (chlorophyll and anthocyanin) mutations were associated, in several cases, with reciprocal translocations. Morphological mutations showed, however, a higher percentage of chromosomal aberrations. From the M_3 to the M_4 generation the number of aberrant progenies generally decreased. This was expected because some reciprocal translocations became homozygous and therefore not detectable at meiosis. Among the physical mutagenic agents used, neutrons were the most efficient in inducing chromosomal aberrations. In Cappelli variety no structural aberrations were found in material treated with chemical mutagens, while in Aziziah variety complex reciprocal translocations were also found. In both varieties, structural aberrations (such as reciprocal translocations and deletions), aneuploid individuals, and abnormalities in meiosis (such as asynapsis, total or partial desynapsis, total or partial stickiness, and spindle disturbance) were found. Among the several types of aberrations affecting the meiotic process, desynapsis was of particular importance, since this type of disturbance often leads to aneuploidy. (BBB)

20145 CYTOLOGICAL STUDY OF EMBRYOLOGICAL DEVELOPMENT OF DROSOPHILA MELANOGASTER WITH X IRRADIATION IN EARLY DEVELOPMENT. Schneider-Minder, Annemarie (Eidgenoessische Technische Hochschule, Zurich). Int. J. Radiat. Biol., 11: 1-20(1966). (In German).

Eggs of Drosophila melanogaster were x-irradiated at two stages of different radiosensitivity of the first cleavage division (inter-/prophase and ana-/telophase) each stage receiving a different dose (1000 or 650 R, respectively). This resulted, in spite of the differences in radiosensitivity, in approximately equal rates of embryonic mortality (about 85 per cent). Regardless of the stage irradiated, approximately 80 per cent of the eggs died in early stages of embryonic development, i.e., before blastoderm formation, and approximately 5 per cent died in late stages of embryonic development. At different times after irradiation eggs were fixed and investigated cytologically. Regardless of the stage irradiated, the same lethal syndromes occurred. Those eggs that die in early phases of embryonic development exhibit one type of a rather uniform lethal syndrome only: first the multiplication of nuclei ceases, then that of chromosome division; finally the increase in number of protoplasmic islands comes to an end. Before disintegrating, these eggs usually contain 8 nuclei, which seem to be mostly octoploid; the larger part of the eggs has 64 protoplasmic islands. The main cause of the lethality is probably an induced mitotic block, which itself could at least partly be caused by chromosomal bridges. Among the eggs, which die late in embryonic development, very different syndromes were recorded, which can manifest themselves at stages from the preblastoderm to very late embryonic development. These syndromes are probably brought about by different radiation-induced losses of either whole chromosomes or of chromosome parts; they may also be caused by alterations in the informational content of the genome. (auth)

20146 STUDIES ON THE USE OF ^{32}P IN MUTATION BREEDING IN SUMMER WHEAT. III. THE CHLOROPHYLL MUTATION RATE AND THE MUTATION SPECTRUM AFTER ^{32}P TREATMENT AT VARIOUS STAGES OF ONTOGENESIS. Keppler, E.; Hentrich, W. (Univ., Jena, Ger.). Zuechter, 31: 162-72(1961). (In German).

The mutagenic effect of ^{32}P on wheat, as measured by mutations of the chlorophyll system, was studied in seed beds, water cultures, and sand cultures after ^{32}P administration in various stages of ontogenesis. The mutation rates observed were related to the developmental stage of the plants at the time when the ^{32}P was added to the nutrient solution. The highest mutation rates were obtained when ^{32}P was added after meiosis and by soaking of air-dried seeds in ^{32}P solution. The reason for the variation of the mutatability with the developmental stage of the plants did not seem to be their varying sensitivity. It was more likely that it was because of the different type of effect of ^{32}P in the different phases. Although ^{32}P was deposited primarily in vegetative tissue during the vegetative phase, during the generative phase a greater deposition of ^{32}P was observed in the generative tissues. The mutational spectrum, consisting of the relative frequency of the appearance of the various mutation forms, was equal in all phases studied. As expected, the chimeric nature of the F_1 plants was less when ^{32}P was given before meiosis than when it was given postmeiotically. However, after treatment of the seeds, with few exceptions, only one spicule was always mutated. Because a somewhat greater mutation rate was obtained by ^{32}P treatment after meiosis, from the standpoint of protection from radiation in breeding these plants, it was considered less dangerous and technically simpler to treat the air-dried seeds. (BBB)

20147 ANALYSES OF CROSS-POLLINATION IN WHEAT (T. DURUM) BY MEANS OF A GENETIC MARKER. Bozzini, A.; D'Amato, F.; Monti, L. M.; Scarascia Mugnozza, G. T. (Centro Studi Nucleari della Cassaccia, Rome). Genet. Agr., 18: 157-73 (1964). (In Italian).

To study the frequency of outcrossing in Triticum durum plants raised from both irradiated and unirradiated seeds, four trials were conducted during two years. Two recessive chlorina (yellow-green) mutants of Cappelli variety were used as genetic markers (R_4/172 and R_4/188). Seeds of chlorina and the parent line Cappelli (green) were sown in such a way as to have every one of the chlorina rows flanked, on both sides, by Cappelli rows. For one plot, unirradiated chlorina seeds were used; for the remaining two, chlorina seeds irradiated with 9 kR and 18 kR of x rays, respectively, were sown. The seeds were irradiated at 250 kV and 1425 R/min after being equilibrated at 9% water content. All chlorina plants in each plot were harvested separately and their spikes were analyzed in the greenhouse for occurrence of green seedling, assumedly resulting from cross-pollination with Cappelli. Outcrossing frequency was calculated on both a spike and a seedling basis. In unirradiated materials in the four trials the frequency of spikes with outcrossing events was between 0.5% and 2.89%, and the frequency of green seedlings between 0.18% and 1.76% (outcrossing). An increase over control in the frequency of outcross seedlings was seen in the material irradiated with 18 kR of x rays, while no difference was found between the control and the 9 kR series. The frequency of outcrossing events in the control portion of each plot was higher than in the peripheral portion, probably because of higher pollen concentrations in the center of the plot. Increase in outcrossing frequency in irradiated material apparently resulted from the reduction in spike fertility induced by irradiation: in the 18 kR series, the frequency of spikes showing a spike fertility lower than 50% was 18.18 as opposed to 8.26% in the controls. Frequency of reversion of chlorina to green in the two mutants used was low, as ascertained by analysis of chlorina spikes prevented from undergoing cross pollination by bagging. If it is assumed that the frequency of cross-pollination between chlorina plants (which could not be determined with the present experimental design) is either identical or comparable to that of the outcrossings chlorina X green, the real outcrossing figures in this material are twice or nearly twice those reported. That outcrossing in T. durum is of normal occurrence in the environmental conditions of the experimental fields is shown by the cases of cross-pollinations found in our collection of induced mutants. In a total of 223 true-breeding M_3 mutant progenies, 34 (15.2%) showed evidence of outcrossing, the frequency of individuals derived from cross-pollination being 0.96%. It is concluded that careful control of pollination in T. durum is necessary both in pure line maintenance and in experiments with mutagenic agents. (BBB)

20148 RADIOBIOLOGICAL STUDIES ON PLANTS. IV. GAMMA-RAY-INDUCED CHLOROPHYLL MUTATIONS AND MUTATION FREQUENCIES IN WHEAT AND OATS. Nishiyama, Ichizo; Ichikawa, Sadao (Kyoto Univ.). Idengaku Zasshi, 36: 175-83(June 1961).

Seeds of Triticum vulgare, Avena sativa (monosomic plants), and A. strigosa were γ irradiated with 10- to 40-KR doses from a ^{60}Co source and induced chlorophyll mutations and mutation frequencies were investigated in their X_2, X_3, and X_4 progenies. Chlorophyll mutations were found in both species of oats. In A. sativa, 4 kinds of chlorophyll mutations (yellow, cream-I, cream-II, and stripe) were obtained. In A. strigosa, 9 kinds (albino-I, -II, -III, -IV, -V, whitish cream, cream stripe, yellow stripe and stripe) were obtained. No chlorophyll mutations were found in T. vulgare. An albino form was obtained most frequently and constituted 46.7% of all the chlorophyll mutants of A. strigosa. Chlorophyll mutation frequency per roentgen unit per spike or panicle progeny was 0×10^{-6} in T. vulgare, 3.9 10^{-6} in A. sativa, and 7.0×10^{-6} in A. strigosa. Mutants were due to a single or to 2 independent gene mutations. Some mutants showed significantly lower segregation ratios than the expected ones. (BBB)

20149 STUDIES OF INDUCED MUTATIONS IN PEAS. XV. EFFECT OF ENVIRONMENT OF THE X_1-GENERATION ON ETHYLMETHANESULPHONATE-TREATED AND GAMMA-IRRADIATED WEITOR PEAS. Blixt, Stig (Plant Breeding Inst., Weibullsholm, Sweden). Agri Hort. Genet., 24: 62-74(1966).

Pea seeds of the Weitor variety were treated with ethyl methane sulfonate (EMS) or γ rays. In the EMS series, concentrations of 0.1, 0.15, 0.2, 0.25, and 0.3% were used. In the γ-ray series, doses of 5, 7, 9, 11 and 13 krad were used. Reasons were sought for the wide variations in the effects observed. Treated seeds were planted in three different localities: (1) in a greenhouse, (2) in a field with a medium heavy clay soil (W series), and (3) in a field with a light, sandy soil (RH series). For germination and survival, the greenhouse series gave the best results and the W series the worst. As regards the number of seed-yielding plants in X_2, the greenhouse series and the RH series were about equal with the EMS group, and the greenhouse series was better with the γ-ray treatment. The W series completely failed, only one γ-irradiated plant surviving to give seed, and none of the EMS-treated plants survived. The mutation rates were 1.5 times higher in the RH series than in the greenhouse series for γ-ray treatment, and 2.5 times higher for EMS treatment. Thus the growing conditions of the X_1 generation seriously affected germination, survival, seed yield, and mutation rate. When the material was followed to the X_3 generation, many mutations were obtained, which were represented in X_2 only by heterozygotes. (BBB)

20150 INVESTIGATIONS ON THE BREEDING OF CITRUS TREES. II. SEEDLESS FRUIT INDUCED BY IRRADIATION OF POLLEN. Tachikawa, Tadao; Hara, Setsuo (Shizuoka Prefectural Citrus Experiment Station, Japan). Bull. Shizuoka Prefect. Citrus Exp. Sta., No. 5, 511-17(Oct. 1965). (In Japanese).

Experiments carried out between 1958 and 1960 on the irradiation of pollen of citrus flowers of various varieties, in attempts to introduce improvements of economic importance, are reported. X ray doses of 10, 20, 40, 60, and 100 kR were used as well as ^{60}Co γ-ray doses of 2, 4, 7, 10, 20, and 40 kR. Of the varieties irradiated, Choju-kinkan (F. obovata), Hassaku (C. hassaku), Hyuganatsu (C. tamurana), and Natsudaidai (C. natsudaidai) were induced to bear seedless fruits, i.e., parthenocarpy was demonstrated in these varieties. By use of ^{60}Co γ rays at up to 40 kR doses or x rays at up to 100 kR to the pollens of kumquat, Natsudaidai, and other citrus varieties, pollen germination was not affected. However, the fruits pollinated with the pollen which had been treated with irradiation doses of 10 kR or over produced reduced numbers of seeds, especially of complete seeds, while shrivelled seeds increased. Treatment with ^{60}Co γ rays at 20 KR of the pollen of Choju-kinkan or with x-ray doses of over 10 KR or γ rays of 30 KR of the pollen of Natsudaidai (C. natsudaidai) resulted in plants with seedless fruits. (BBB)

20151 STUDIES OF INDUCED MUTATIONS IN PEAS. XIV. SEGREGATION OF XANTHA MUTANTS. Blixt, Stig (Plant Breeding Inst., Weibullsholm, Sweden). Agri Hort. Genet., 24: 56-61(1966).

Segregation of a xantha mutant of peas induced by x rays is reported. Chlorophyll mutations, especially the sublethal or lethal ones, often segregate with a pronounced deficit of mutants, i.e., homozygous recessives. It was of interest for the determination of initial mutation rates to ascertain whether this deficit is caused by gamete or zygote elimination. X irradiation of the variety Parvus was carried out, and in the X_4 generation a xantha mutant was observed in a series which had received 15,000 rad. The X_1 generation of the 15,000-rad group gave only 13 surviving plants, and of these, none were xantha. The X_2 generation consisted of 13 families and altogether 316 plants, but no xantha mutants were observed. For the X_3 generation, 52 progenies were grown in the field, altogether around 6000 plants, but no xantha plants were observed. In the X_4 generation, also grown in the field, the

progenies of each individual X_3 family were kept separate, but the progenies from the X_3 plants within the family were joined, and the first observations of xantha mutants were made. Five xantha plants were obtained out of 1771, or 0.3%. The low frequency of xantha plants in the X_4 lots was at least partly due to the fact that both segregating and nonsegregating X_3 plant progenies were joined in making up the X_4 lots. The segregation of a xantha mutation induced by x rays in the variety Parvus was followed over four more generations (X_5, X_6, X_7, and X_8). The data obtained indicated that the mutation which arose in one X_1 plant was separated in two sublines, which were phenotypically indistinguishable, but differed in mode of segregation as a response to environment. The deficit of xantha plants was probably due to zygote elimination, for the most part at a stage between fertilization and seed maturity. (BBB)

20152 CHROMOSOME ABERRATIONS IN PERIPHERAL BLOOD CELLS IN MAN FOLLOWING CHRONIC IRRADIATION FROM INTERNAL DEPOSITS OF THOROTRAST. **Fischer, P. (Univ., Vienna); Golob, E.; Kunze-Muehl, E.; Haim, A. Ben; Dudley, R. A.; Muellner, T.; Parr, R. M.; Vetter, H. Radiat. Res., 29: 505-15(Dec. 1966). (TID-22840).**

Twenty patients who were known to have received Thorotrast from 19 to 27 years previously, and whose residual body burdens had been measured by whole-body counting, were examined for the presence of chromosome aberrations in dividing cells from short-term peripheral blood cultures. Aberrations were present in 19 of the 20 persons examined. The one patient in whom no aberrations were observed had received Thorotrast for retrograde pyelography. His residual body radioactivity was very low. Statistical tests of the data for evidence of a dose-effect relation revealed a significant correlation between the number of chromosome breaks and the radioactive body burden. (auth)

20153 SURVIVAL OF EXCESS THYMIDINE SYNCHRONIZED CELL POPULATIONS IN VITRO AFTER X-IRRADIATION IN VARIOUS PHASES OF THE CELL CYCLE. **Vos, O.; Schenk, H. A. E. M.; Bootsma, D. (National Defence Research Organization, TNO, Rijswijk, Netherlands). Int. J. Radiat. Biol., 11: 495-503(1966).**

Cells from a human kidney-cell line were synchronized in vitro by a double excess thymidine treatment. Exposure to radiation at various times after thymidine synchronization revealed a high radioresistance of cells at the end of S-phase and the beginning of G_2-phase. A blocking of DNA-synthesis at the beginning of S-phase by a third thymidine exposure inhibited progression to a more radioresistant phase; blocking of DNA-synthesis at the end of S-phase maintained the cells in the radioresistant phase. A third thymidine exposure at the beginning of G_2 had no effect on changes in radiosensitivity. (auth)

20154 PROLIFERATION CHARACTERISTICS OF CULTURED MAMMALIAN CELLS AFTER IRRADIATION WITH SPARSELY AND DENSELY IONIZING RADIATIONS. **Westra, A.; Barendsen, G. W. (TNO, Rijswijk, Netherlands). Int. J. Radiat. Biol., 11: 477-85(1966).**

Clone size distributions of mammalian cells cultured by Puck's technique have been determined after irradiation with various single doses of 250-kVp x-rays and 3.2-MeV α-radiation. The distributions broadened progressively with increasing doses of either of the two types of radiations. No qualitative differences were observed between the actions of the two radiations. In addition proliferation kinetics were studied of microclones, which 15 days after irradiation with x- or α-radiation, corresponding to 14 doubling times of clones developed from unirradiated cells, contained less than 50 cells. Some of these microclones decreased with respect to their number of cells and finally disappeared. However, other microclones slowly increased in cell number and had retained the capacity for unlimited proliferation. Nevertheless, these macroclones which had developed from microclones show many unsuccessful mitoses even after a large number of divisions. No differences were observed in the characteristics of this non-lethal damage produced by 250-kVp x-rays and 3.2-MeV α-radiation. (auth)

20155 THE SO-CALLED RECOVERY PHENOMENON AFTER IRRADIATION IN DROSOPHILA MELANOGASTER. **Trout III, William Edgar. Bloomington, Ind., Indiana Univ., 1965. 108p.**

Thesis.

The drop in the mutation frequency from the first to the second day after X-irradiation of Drosophila melanogaster males, hitherto known as the recovery phenomenon, was observed by the use of recessive sex-linked lethal mutations induced in either a rod- or a ring-X chromosome. This finding with a ring-X demonstrates that point mutations can undergo this phenomenon. When males were not allowed to mate the first day after irradiation, the mutation frequency on the second day was intermediate between those for males mated both days, suggesting that mature males accumulate their sperm when not allowed to mate, and that the sperm ordinarily used on the first and second days after irradiation are differently sensitive to X-rays. Methods are described for investigating the use of sperm by the male, by using ^{32}P and tritiated thymidine as sperm labels. By feeding or injecting males with tritiated thymidine, and preparing squashes of the sperm transferred to females, the label transferred can be studied quantitatively by scintillation counting. The samples are also in a form suitable for chemical treatment, staining and autoradiography. Studies with injected adult males delayed in mating suggest that seminal fluid is accumulated to some extent in unmated males, and is used rapidly by mating males. Evidence concerning the time from injection or feeding of the label to the transfer of labeled seminal fluid or sperm to females, suggests that in these experiments the time is the same for ^{32}P and tritiated thymidine labeling. Moreover, the time seems to be the same for males labeled as larvae, and as young adults. There appear to be two labeling peaks, one about 7-8 days after labeling, which may represent the use of labeled seminal fluid; and another peak 12-13 days after labeling, perhaps representing the first use of labeled sperm. The X-ray experiments offer strong evidence that the recovery phenomenon is the result of a radiosensitivity gradient in sperm used on different days after irradiation, and is not the result of an actual recovery process. The results from the labeling experiments are not inconsistent with this view. (auth)

20156 STRUCTURE AND FUNCTION OF THE 3C1,2,3 REGION OF THE X-CHROMOSOME OF DROSOPHILA MELANOGASTER. **LeFever, Hermon Michael. Austin, Tex., Univ. of Texas, 1966. 61p.**

Thesis.

Historically, the region of the X-chromosome of Drosophila melanogaster designated as 3C1,2,3 has been associated with the recessive eye mutant white (w). One of the primary objectives of this study was to determine if a fine structure analysis of the locus would uncover mutants concerned with only one basic metabolic process or if the structure analysis would uncover mutants concerned with diverse metabolic processes. Another objective was to establish the specific cytological limits of the white locus and to determine what other genetic traits, if any, can be localized to the 3C1,2,3 region. The region in question was screened, by the use of X-chromosome deficiencies, for all mutations induced by X-ray. The mutants recovered were balanced and then subjected to further genetic analysis. Four X-ray lethals were obtained which die when screened against a 3C1 deficiency. The results of a complementation analysis show that two of the lethals are non-complementary, while all others complement in combination with each other. Recombination analysis of the lethals established their spatial relationship to one another and indicated that the relationship of the 3C1 lethals to the white locus was one of close proximity, but without overlap regarding location. Three white mutants were recovered and were analyzed with respect to their location in the locus and their relationship to the recessive eye mutant zeste. The mutant w^{cm} was found to possibly be isolocal to the white locus mutant w^{Bwx} and a nonsuppressor of zeste. The mutant w^{65a25} was a non-suppressor of zeste and located between the mutants w^{a} and w^{cm}. The third mutant sp-w^{4} was found to be a true allele of the mutant sp-w^{1}. A mutant designated as 11G3 was reported in the literature to be located in 3C1 and act as a dominant suppressor of zeste. Analysis of this mutant in this study indicated that the mutant 11G3 is located in or near the zeste locus (3A3). Two white lethals were analyzed in this study. Analysis indicated that the lethal associated with one of the mutants occurs not in the white region but elsewhere in the X-chromosome. The second white lethal was lethal because of a loss of 3C1 and was shown to act as a zeste suppressor. The results of this study indicate that the white locus is located definitely in 3C2 and possibly in 3C3, but not in 3C1. The white locus is a region concerned only with the process of eye pigment production and does not exhibit pleiotrophy. (auth)

20157 GENETIC X-RADIATION DAMAGE AND ITS MODIFICATION BY SOME GASES AND A TIME FACTOR IN DROSOPHILA MELANOGASTER. **Yoon, Jong Sik. Austin, Tex., Univ. of Texas, 1965. 60p.**

Thesis.

Drosophila melanogaster (Oregon-R, Oak Ridge Strain) males, 19 to 21 hours old, were x rayed with a total dose of 1000 R or 3000 R given in two equal fractions of 500 R or 1500 R at a dose rate of 500 R per minute, except Experiment No. 1 in which they were given a single dose of 1000 R at 24 ± 1°C in several gas environments, with a time interval of 20 minutes or 40 minutes between the two doses. At each change of gases, the system was evacuated to remove all gases, then flushed with helium for 1 minute. Tests using CO were carried out in the dark and the

others in the light, both at 1 atmosphere of the gas or gas mixture. In order to study the genetic radiation damage and its modification in the presence of several gases and a time factor, the frequencies of dominant lethals and translocations induced in cells which were in different stages of spermatogenesis were scored using seven sequential 2-day matings over a two-week test period. The frequency of dominant lethals increased from sperm to spermatids and meiotic cells, then decreased in spermatogonia. The spermatogonial cells were the least susceptible to x rays. The cycle of damage for dominant lethals is similar to that for translocations, but does not coincide with it completely, and the peaks of damage for both are located in early postmeiotic stages. The cycle of frequencies of translocations coincides with that of percentages of sterility of F_1. The coincidence of frequencies between translocations and the sterility demonstrates that the mechanisms of damage for both are related, at least in part. The NO (nitric oxide) effect on sperm and late spermatids is more drastic than the oxygen effect, but a major fraction of the effect is to cause the death of the sperm, or to slow down spermatogenesis. It is possible to conclude that the duration(s) of 4 minutes of gases in post-treatments is too short to modify the damage. CO during radiation increases genetic damage above the other gases tested. No evidence of reduction in damage due to gas changes between radiation doses was demonstrated. There are few or no translocations recovered from premeiotic cells. The Y-chromosome was in 10.8% of total breaks, or about ¼ as frequently as the two autosomes tested, and chromosomes 2 and 3 equally participated in an interchange. The relations of these data to other investigations concerning the possible actions of various gases and a time interval between doses in modifying x radiation damage are discussed briefly. (Dissertation Abstr.)

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Refer also to abstracts 19720, 19883, 19893, 19955, 19976, 19977, 20029, 20111, 20289, 21367, and 21851.

20158 (AD–643204) STUDY TO DETERMINE REQUIREMENTS FOR PUBLIC HEALTH FACILITIES IN A POST-THERMONUCLEAR ATTACK ENVIRONMENT. Final Report. Hallan, J. B. (Research Triangle Inst., Durham, N. C. Operations Research and Economics Div.). Nov. 1966. Contract PH-109-66-50. 95p. CFSTI $3.00 cy, $0.65 mn.

Requirements for adequate public health facilities and operations (water, sewage, and solid waste) in a post-thermonuclear attack environment were studied. Four cities were surveyed to evaluate solid waste disposal techniques and to determine simple types of equipment available for emergency treatment of water and sewage. A questionnaire was subsequently developed to ascertain the knowledge level and preparedness of solid waste treatment personnel to cope with disaster conditions. This questionnaire and a similar one dealing with water and sewage treatment operations (developed under a previous contract) were then administered to the four cities. Findings from both questionnaires are summarized and evaluated. (auth)

20159 (AEET–268) PREOPERATIONAL SEARCH FOR BASELINE RADIOACTIVITY, CRITICAL FOOD, AND POPULATION GROUP AT THE TARAPUR ATOMIC POWER STATION SITE. Kamath, P. R.; Bhat, I. S.; Khan, A. A.; Ganguly, A. K. (Atomic Energy Establishment, Trombay (India)). 1966. 34p. Dep. mn.

A preoperational environmental survey was made at the site of the Tarapur Atomic Power Project. Programs were devised for monitoring land, land produce, sea water, seafood, drinking water supplies, and air in an area from 0 to 32 km of the site. A survey of 100 families in the area was designed to obtain an estimate of daily per capita food consumption among a variety of professional types, e.g., farmers, fishermen, businessmen, and teachers. Contamination of water supplies was ruled insignificant because drinking water in the area is obtained primarily from wells. Dietary surveys showed that ^{90}Sr and ^{137}Cs contamination in the Tarapur diet is attributable to cereals and pulses (predominately rice). It was concluded that activation products were likely to enter the food chain via seafood harvested offshore. Strontium-90 to calcium ratios in various dietary components were compared to those in New York City. General types of diets were found to be independent of socioeconomic conditions. (H.G.D.)

20160 (ARCRL–16) ANNUAL REPORT, 1965–66. (Agricultural Research Council, Wantage (England). Radiobiological Lab.). Sept. 1966. 80p. Dep. mn. BIS $1.70. HMSO 8s. 6d.

Separate abstracts were prepared for the three sections of the report. Four appendices giving results of surveys on cesium-137 and strontium-90 in milk are included. (H.L.W.)

For abstracts of individual sections see: 20019, 20161, and 20162.

20161 (ARCRL–16, pp 3-20) RADIOACTIVITY IN HUMAN DIET, 1965. (Agricultural Research Council, Wantage (England). Radiobiological Lab.).

Results of measurements on radioactivity deposition in rain are reported; these data give an early indication of changes in the extent of environmental contamination. Investigations of contamination of human diet with radioactivity from world-wide fallout are reported. The complete results of surveys of ^{90}Sr and ^{137}Cs in human diet during 1965 are given and, in addition, results for milk until June 1966. Maps and tables are presented to show results of a country-wide survey of ^{90}Sr in milk, cheese, vegetables, and flour. Results of surveys of ^{90}Sr in flour produced in Australia and ^{90}Sr in items of diet in Hong Kong are also presented. (H.L.W.)

20162 (ARCRL–16, pp 21-5) SURVEYS OF ENVIRONMENTAL RADIOACTIVITY: A REVIEW OF REQUIREMENTS. (Agricultural Research Council, Wantage (England). Radiobiological Lab.).

The primary requirement of surveys of environmental contamination by radioactive materials is to obtain adequate information for medical assessment. Another objective is to obtain information on food chain mechanisms. The significance of exposures from fallout in consequence of past weapons tests is discussed. Other topics discussed are: the transfer of radioactivity to diet; future investigations of ^{90}Sr and ^{137}Cs in diet; and surveys of ^{131}I. (H.L.W.)

20163 (BNL–50001) 1964 ENVIRONMENTAL MONITORING RADIATION LEVELS AT BROOKHAVEN NATIONAL LABORATORY. Hull, A. P. (Brookhaven National Lab., Upton, N. Y.). June 1966. Contract AT(30-2)-Gen-16. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements of natural background radiation levels (including fallout contributions) and of perturbations in this background attributable to Laboratory operations have been obtained on site and in the vicinity of Brookhaven National Laboratory. These perturbations include contributions from the gaseous and air particulate effluent of the stack of the Brookhaven Graphite Research Reactor, from multicurie field gamma sources, and from the discharge of low-level liquid wastes into the headwaters of the Peconic River. The natural background external radiation level declined to an average of 2.93 mR/wk during 1964. No increment was perceptible from fallout from the first Chinese weapons test, which was detected late in October. The highest yearly on-site level attributable to Laboratory operations was 3.22 mR/wk (for 168 hr), well below the established radiation protection standards for individuals in controlled areas. The highest yearly radiation level at the perimeter averaged 2.57 mR/wk, to which the ecology forest contributed 1.59 mR/wk; the balance was from ^{41}Ar. The total is 26% of the established yearly standard of 500 mR for individuals in uncontrolled areas. No airborne radioactivity attributable to Laboratory operations, other than ^{131}I, was detectable during routine environmental monitoring. The yearly average gross β concentration of samples counted after a 30-hr delay (to allow for the decay of almost all the natural radioactivity) was 1.10 pCi/m^3, with a 1-day maximum of 9.27 pCi/m^3. An intensive effort was made to sample and evaluate very low environmental concentrations of airborne ^{131}I during 1964. The highest yearly average at the perimeter was determined to be 0.0037 pCi/m^3, which may be compared with the radiation protection standard concentration of 100 pCi/m^3 in uncontrolled areas. Fallout ^{131}I from the first Chinese nuclear weapons test was also present in an average concentration of 0.0062 pCi/m^3 from October 28 to November 29. The activity in precipitation declined to an average of 78 mCi/mi^2/mo. The average age concentration was 339 pCi/liter. Liquid wastes discharged to the headwaters of the Peconic River averaged 72 pCi/liter, about 6.7% of a calculated radiation protection standard that assumes the ^{90}Sr content to be 20% and the balance of the isotopes present to be unknown β or γ emitters. Monthly downstream grab samples from the Peconic River ranged from 115 to 14 pCi/l, while those from off-site control locations averaged 17 pCi/l. The highest concentrations of individual isotopes in bottom sediments (11.2 pCi/g of ^{60}Co, 6.9 pCi/g of ^{137}Cs, and 1.3 pCi/g of ^{144}Ce) were found between the on-site outfall and a point about a mile downstream from the Laboratory perimeter. A similar distribution was found in underwater vegetation, the highest concentrations being 34.3 pCi/g of ^{60}Co, 13.3 pCi/g of ^{144}Ce, and 4.0 pCi/g of ^{137}Cs. Concentrations in both sediment and vegetation were found to decline to near background levels beyond three miles downstream. The concentrations of ^{131}I in routine monthly milk samples obtained from several nearby farms were all <10 pCi/l,

except for a brief time early in November. The applicable Radiation Protection Guide, assuming an intake of 1 l/day, is 100 pCi/l. The environmental monitoring program has established that during 1964 radiation levels attributable to Laboratory operations were maintained well below the established radiation protection standards of the AEC for external exposures, air particulate concentrations, and liquid effluent concentrations. Radiation levels attributable to fallout were also well below these established limits. (auth)

20164 (CEX-62.12) ENERGY AND ANGULAR DISTRIBUTION OF NEUTRONS AND GAMMA RAYS: OPERATION BREN. Thorngate, J. H.; Auxier, J. A.; Haywood, F. F.; Helf, S. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 94p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In order to understand better the transmission and scattering of radiation in air, a series of measurements were made to determine the energy and angular distributions at large distances from the Oak Ridge National Laboratory Health Physics Research Reactor and an 800-Ci ^{60}Co source. Both sources were positioned at various elevations on a 1527-ft tower while data were acquired by detectors located in collimators at either 750 or 1000 yd from the base of the tower. Good measurements were obtained of neutron and gamma-ray doses from the HPRR and gamma doses from the ^{60}Co source as a function of angle of incidence. Scintillation spectra of the gamma rays from the ^{60}Co source were also obtained. No useful spectrum information was obtained from the HPRR. (auth)

20165 (CLOR-58/D) POMIARY DAWEK INDYWIDUALNYCH ZA POMOCA DAWKOMIERZY FOTOMETRYCZNYCH W POLSCE W LATACH 1963-1965. (Personnel Film Monitoring in Poland in the Years 1963-1965). Jasiak, J.; Musialowicz, T.; Wysopolski, J. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 25p. (In Polish). Dep.

The method and results of a systematic personnel film monitoring carried out by the Central Laboratory for Radiological Protection in the period 1963 to 1965, in laboratories and establishments using radioactive isotopes are described. The number of monitored persons with doses exceeding the quarterly permissible dose decreased in comparison with the previous years. The results from the years 1963 and 1964 were compared with similar one in the German Democratic Republic. (auth)

20166 (COO-651-41) SURVEY OF ENVIRONMENTAL RADIOACTIVITY, JULY 1966-DECEMBER 1966. (Minnesota Dept. of Health, Minneapolis. Rural Cooperative Power Association, Elk River, Minn.). Feb. 1967. Contract AT(11-1)-651. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Environmental radioactivity was measured in the Elk River Reactor area. The gross beta radioactivity was determined in air particulates, in surface water, and in precipitation. Results are tabulated with previous values taken between 1961 and 1966 so that the influence of atmospheric weapons testing would be apparent. Determinations of cesium-137, iodine-131, and strontium-90 in milk are also reported in tabular form. (H.L.W.)

20167 (COO-1500-3) RADON PROGENY INHALATION STUDY AS APPLICABLE TO URANIUM MINING OPERATION. Annual Report No. 2, Calendar Year 1966. Dahl, Adrian H.; Schiager, Keith J. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology); Reece, Richard J.; Jacoe, Paul W. (Colorado State Dept. of Public Health, Denver. Div. of Occupational and Radiological Health). Feb. 28, 1967. Contract AT(11-1)-1500. 112p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The work was conducted in the Cotter Corporation (Schwartzwalder) mine 7 miles north of Golden, Colorado. Objectives of the study were as follows: to investigate the general relationships of the physical characteristics of mine aerosols and exposure conditions to the deposition, retention, and translocation of the radioactive materials in humans; to investigate the relationships of various exposure surveillance methods to the actual exposure hazards from radon and its progeny; and to investigate the effectiveness of various methods for controlling exposures to radon and its progeny in mine atmospheres. Methods of ventilating the mine tunnel are described. Factors such as barometric pressure changes and blasting operations which influence the radioactivity concentration in the mine air are discussed. A laboratory trailer was designed and constructed for in vivo gamma counting in subjects exposed to the mine atmosphere. For measurements of controlled radioactive aerosols in the laboratory an aerosol simulation chamber was constructed. The radon source consisted of crushed uranium ore enclosed in a sealed metal drum. A spirometer was constructed for accurate flow meter calibrations. A list of objectives of aerosol characterization is presented. Linear differential equations are given to show relations between concentrations of radon progeny in the mine atmosphere and their observed disintegration rates on a filter paper air sample. Studies were made on deposition and retention of short lived daughters in the human respiratory system. Results are presented in the form of tables and graphs. Results indicated that various mine atmospheres produce different deposition patterns in the human respiratory system. It is suggested that factors responsible for these differences could be radon progeny activity, concentrations of ionic activity, equilibrium ratios of progeny and carrier aerosol characteristics. A bioassay study was conducted to determine whether a correlation existed between the integrated exposure of uranium miners to the mine atmosphere and one or more of the long-lived daughters (^{210}Pb, ^{210}Bi, ^{210}Po) appearing in biological samples collected from miners. Results are tabulated. A radon film badge study was conducted on 15 miners wearing badges with an exposure time of one, two, or three weeks. The results showed higher exposures in working areas where atmospheric concentrations were known to be higher by grab sample techniques. (H.L.W.)

20168 (DPSPU-65-30-31) RADIOLOGICAL PROTECTION IN A TRITIUM SEPARATIONS FACILITY. Nichols, D. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Jan. 1966. Contract AT(07-2)-1. 8p. (CONF-660403-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Symposium on Radiological Protection of the Worker by the Design and Control of his Environment, Bournemouth, Eng.

The Savannah River Plant is the major center for tritium production in the United States. Tritium is produced by neutron irradiation of Li in the reactors and is subsequently extracted from the Li target elements in a separations facility. Radiological protection was one of the foremost objectives in the design of the separations facility and in the selection of operating procedures. Methods used for the control of radiological health hazards are described. (C.H.)

20169 (HI-693-RR) DAMAGE ASSESSMENT MODELS. Ayres, Robert U. (Hudson Inst., Inc., Harmon-on-Hudson, N. Y.). Dec. 30, 1966. Contract OCD-PS-65-64. 55p. CFSTI $3.00 cy, $0.65 mn.

Comparisons are presented for 14 computerized damage-assessment models developed by 8 organizations. Comparative methods of specifying designated and actual ground-zeros, location and distribution of population and other assets, casualties, property damage and fallout deposition are described. Subsidiary models for damage and injury as a function of burst distance (for blast), fallout intensity as a function of weapon size, distance and wind speed, radiation mortality as a function of equivalent residual dose (ERD), and firespread as a function of fuel density, distribution and wind conditions, among others, are discussed. Approximations and potential sources of error are listed together with some comments regarding the need for sensitivity analysis and the implications of model uncertainties for modes of use. (auth)

20170 (HSR-RR-66/14-PR) A STUDY OF THE DEMOGRAPHY OF NUCLEAR WAR. Pendleton, William W. (Human Sciences Research, Inc., McLean, Va.). May 1966. Contract OCD-PS-65-29. 241p.

Results are presented from a study of some of the possible demographic consequences of nuclear war on the population of the U.S.A. and their implications for the surviving society. Factors affecting the composition, as well as the size of surviving populations, are considered; and variables and concepts used to study populations are reviewed. Data from previous studies on the effects of a hypothetical 2,000 megaton attack on a mixed industrial-military target are analyzed as to effects on the composition of the labor force and the numbers of people in selected occupations, effects on the religious composition of the population, effects on representation in Congress, and effects on the distribution of survivors among urban and rural populations. Possible areas for Civil Defense action and planning are considered. (105 references.) (C.H.)

20171 (HSR-RR-66/14-Pr(App.1)) A STUDY OF THE DEMOGRAPHY OF NUCLEAR WAR. APPENDIX I. EMPIRICAL GUIDELINES FOR THE SELECTION OF DEMOGRAPHIC VARIABLES AND AREAL UNITS FOR STUDYING POSTATTACK SOCIETY. Hadden, Jeffrey K.; Borgatta, Edgar F. (Human Sciences Research, Inc., McLean, Va.). May 1966. Contract OCD-PS-65-29. 241p.

Methodological approaches used for studies on the demographic characteristics of post-attack society in the event of nuclear war are described. Applications of zonal hypothesis and social area analysis for the study of demographic characteristics of the population that will survive a postulated nuclear attack on the U.S.A. are discussed. Possible applications in Civil Defense planning are discussed briefly. (C.H.)

20172 (NHS-6/61) AIR CONCENTRATION AND SURFACE DEPOSITION FROM STACK DISCHARGE. Sinclair, T. C. (Central Electricity Generating Board, London (England). Nuclear Health and Safety Dept.). Oct. 1961. 178p. Dep. mn.

Tables and graphs are presented of the results of a computation of the air concentration and surface deposition downwind of a source emitting airborne particulates. Several combinations of meteorological conditions and emission characteristics are used for heights of release up to 250 meters and for distances up to 100 kilometers. (auth)

20173 (NP-16551) RADIOACTIVITY SURVEY DATA IN JAPAN. Numbers 9 and 10. (National Inst. of Radiological Sciences, Chiba (Japan)). Nov. 1965-Feb. 1966. 19p. Dep. mn.

Data on monthly and cumulative deposits of ^{90}Sr and ^{137}Cs at various locations in Japan are presented. Additional data on ^{90}Sr, ^{137}Cs, ^{144}Ce, ^{95}Zr, ^{95}Nb, and ^{106}Ru in airborne dust are presented. Observations on the monthly variation in ^{90}Sr and ^{137}Cs content in milk were conducted at the National Institute of Animal Industry. Tables showing contents of these isotopes in milk from August 1965 to February 1966, are presented. Surface soil samples to determine total deposition of fallout were analyzed. Tables are presented to show ^{90}Sr, ^{137}Cs, and ^{144}Ce content of soil from April 1964 to December 1965. (H.L.W.)

20174 (NP-16593) RADIOACTIVITE DES PLANTES DES BRAS DE L'ISERE EN 1964-1965. (Radioactivity of the Plants of the Tributaries of the Isere River in 1964-1965). Note Bio-V/10. Wlodek, S. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Aug. 1965. 29p. (In French). Dep. mn.

The radioactivity contamination levels of 16 species of plants of the Isere River were studied during the summer and autumn of 1964 and the spring of 1965. Conclusions were made on: the differences of behavior of various plant species with respect to the accumulation of radioactive substances; the seasonal differences of the accumulation; and the contribution of ^{144}Ce, ^{106}Ru, ^{137}Cs, and ^{54}Mn in the contamination of plants. (tr-auth)

20175 (NP-16601) INSTALLATION AND TESTING OF AN AUTOMATIC REMOTE RADIOLOGICAL MONITORING SYSTEM. Final Report. (Gautney and Jones Communications, Inc., Washington, D. C.). July 1966. Contract OCD-PS-64-262. 165p.

An Automatic Remote Radiological Monitoring System which was developed under an OCD research contract was installed in a community and tested for operational characteristics. The system as delivered was capable of being operated via landline telemetry links but considerable engineering effort was required to effect an interface with a vhf radio link. Extensive modification of both the base station and remote station transceivers as well as the monitoring equipment was performed. When the radio telemetry problems had been solved, the system was deployed in Montgomery County, Maryland, which comprises an area of approximately five hundred square miles. The units were installed on school properties distributed throughout the county, and the deployment pattern includes path lengths ranging from three and one-half to fifteen and one-half miles over rolling terrain. Telemetry modes successfully employed in the installation include two vhf single frequency radio links, six standard leased landline links, one combination leased landline—Bell System Audio Carrier link and one combination leased landline—duplex microwave link. The system is now operational and is currently being evaluated, under a separate contract, for effectiveness in its present form and for improvements in reliability and operability that may be incorporated in future systems. (auth)

20176 (NP-16616) ROUTINE SURVEILLANCE OF RADIOACTIVITY AROUND NUCLEAR FACILITIES. Interlaboratory Technical Advisory Committee Report No. 1. (Public Health Service, Washington, D. C. Div. of Radiological Health). Dec. 1966. 28p. GPO $0.25.

A concise, comprehensive, and practical guide for planning, operating, and evaluating the effectiveness of a program for routine surveillance of radioactivity around nuclear facilities is presented. Included are references to regulations and guides for evaluating releases from such facilities, and commentary on the nature and types of wastes to be anticipated; their fate when released to the environment; and recommended procedures for sampling the air, water, milk, food, biota, soil, and people for resulting contamination. (auth)

20177 (NP-16654) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 5, Number 1. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Jan. 1967. 27p. Dep. mn.

Canadian fallout data for December, 1966, national averages of these data, and corresponding values for 1965 are presented. The daily and monthly average of air data for each station in terms of gross beta activity per cubic meter of air and the gross beta activity in precipitation expressed as mCi/km^2 are given. The regular monthly analysis for ^{90}Sr and ^{137}Cs in precipitation was terminated at the end of 1965 because the concentration had reached a very low level. The concentrations of ^{90}Sr and ^{137}Cs in liquid milk samples in units of pCi/l are also given. The average fallout values for December, 1966 showed little change from those of the previous month. However, a marked increase in total beta activity was observed for the precipitation sample collected from Calgary during the month. It was concluded that this was apparently an early indication of fresh fallout from the Chinese test of December 28, 1966. The average concentrations of ^{137}Cs in liquid milk were 35 pCi/l and 39 pCi/l as compared to 14.1 pCi/l and 13.5 pCi/l for ^{90}Sr. Results from total alpha activity and total beta activity determinations on water samples obtained from Lake Huron, Ottawa River, and Winnipeg River for December, 1966 are also presented. Selected samples were analyzed for ^{89}Sr, ^{90}Sr, and ^{137}Cs; data are presented. Results from analyses performed on milk samples from the environment of the Douglas Point reactor site and the Whiteshell Nuclear Research Establishment are given along with results of total beta activity determinations on the McMaster University air filter samples. All of these data were in general agreement with observations made in the fallout program; anomalies that could be attributed to release of contamination from the reactors were not apparent. A short list consisting of selected items from the material available from the Radiation Protection Division on request is included. (B.H.S.)

20178 (NRL-6520) FILTER PACK TECHNIQUE FOR CLASSIFYING RADIOACTIVE AEROSOLS BY PARTICLE SIZE. PART 5. FINAL REPORT. Lockhart, L. B. Jr.; Patterson, R. L. Jr.; Saunders, A. W. Jr. (Naval Research Lab., Washington, D. C.). Mar. 1, 1967. 18p.

During the past several years, a number of collections of radioactive aerosols in the atmosphere have been made on packs of filters of different characteristics, through which an air stream passes sequentially. The radioactivity distribution on the filters has been related to the sizes of the particulate matter in the atmosphere with which the radioactivity was associated. Conditions have been developed for obtaining size distributions in 3 or 4 size groups, in the submicron range, through use of packs consisting of 3 or 4 well-characterized filter media operated in two convenient air flow regimes, 60 to 70 cm/sec and 145 cm/sec. Simple two-filter packs can be employed to monitor the behavior of particulate matter in a restricted size range (e.g., either the >1.0 μ-diameter component or the <0.3 μ-diameter component). The general method is applicable to the sizing of any aerosol material for which suitable analytical techniques are available. Gross β activity levels and concentrations of specific radionuclides in the atmosphere at Washington, D. C., were documented for the period January 1965 through July 1966. (auth)

20179 (NYO-3364-18) LEVELS OF ^{137}Cs IN NORWEGIAN LAMB AND SHEEP, 1964-1965. Madshus, Kjell (Norsk Hydro's Inst. for Cancer Research, Oslo); Stroemme, Aksel (Norsk Radium Hospital, Oslo). Contract AT(30-1)-3364. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Samples of fresh meat from 5 to 6 month old lambs and adult sheep were collected from slaughterhouses. The meat was cut and dried at 100°C for several hours after the addition of distilled water and Na_2CO_3. This mixture was ground and measured by γ spectroscopy. Results are tabulated. Cesium-137 contents in lamb and sheep in the fall of 1964 and in the fall of 1965 from three zones of Norway are presented. There is no constant ratio between cesium-137 content in lamb's meat from the same slaughterhouse from 1964 to 1965, and there is no constant ratio between the cesium-137 content in meat from lamb and sheep from the same slaughterhouse in the fall of 1965. In general, there is a high concentration of cesium-137 in the meat. The meat of lamb and sheep is an important part of diet in the people of Norway, and this contributes significantly to the body burden of cesium-137 in people. (H.L.W.)

20180 (ORNL-P-2897) DOSE DISTRIBUTION FUNCTIONS FOR NEUTRONS AND GAMMA RAYS IN ANTHROPOMORPHOUS AND RADIOBIOLOGICAL PHANTOMS. Jones, T. D.; Auxier, J. A.; Poston, J. W.; Johnson, D. R. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 14p. (CONF-660920-14). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy.

A right circular cylinder, 30 cm in diameter and 60 cm in height, was assumed to be composed of standard soft tissue, and dose as a function of penetration depth was computed for plane beams of incident neutrons. Data are presented for monoenergetic neutrons of various energies up to 14.0 MeV as well as for the neutron spectrum from the Health Physics Research Reactor

(HPRR). The calculations were of a Monte Carlo nature using a slightly revised version of Snyder's linear energy transfer (LET) code. New LET curves were obtained for ions of C, N, O, B, Be, and for protons, tritons, and alpha particles, and recently obtained values of cross sections for these same elements were used with the code. Many previous theoretical treatments of similar problems tended to ignore inelastic scattering reactions due to the complexity of coding, the difficulty of obtaining appropriate inelastic cross sections, and inadequate fast memory capacity of many computational machines. Results of these calculations were compared with those for the infinite slab 30 cm thick in the National Bureau of Standards (NBS) Handbook 63, those obtained for a burro-cadaver exposed to the neutron spectrum from the HPRR, and those presented by Auxier et al., in their description of a belt containing various radiation detection devices to be used in the determination of the orientation of persons exposed to unscheduled criticality excursions. (auth)

20181 (ORNL-TM-1719) WARNING CONSIDERATIONS FOR THE DETROIT TUNNEL-GRID BLAST SHELTER CONCEPT. Lamoureux, Robert L. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 90p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An estimate was made of the response of the public to a civil defense warning system. A mathematical model was used to estimate the ability of the public to respond to various types of warning devices in an environment where hypothetical shelters are located in close proximity to residences. A proposed tunnel-grid blast-shelter complex designed for Detroit that places a shelter entranceway within 4 or 5 blocks of every residence was used for the study. The basic critical variables included warning time, distance from the shelter, and rate of movement to the shelter. The results of the model are expressed in percentages of population reaching the shelter entranceways at any particular time. It was concluded that lack of empirical data made it impossible to analyze satisfactorily the sensitivity of the results of the model study. (C.H.)

20182 (RISO-132) ENVIRONMENTAL RADIOACTIVITY IN GREENLAND IN 1965. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1966. 21p. Dep. mn.

The present report deals with the measurement of fall-out radioactivity in Greenland in 1965. Sr-90 (and Cs-137 in most instances) was determined in samples of precipitation, soil, sea water, vegetation, animals, and drinking water. Estimates of the mean contents of Sr-90 and Cs-137 in the human diet in Greenland in 1965 are given. (auth)

20183 (SU-326-P-16-2) RADIOCHEMICAL STUDY OF THE TRADE WIND INVERSION AT HAWAII. Technical Report No. 74. Kruger, Paul (Stanford Univ., Calif. Dept. of Civil Engineering). Dec. 1966. Contract AT(04-3)-326. 53p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Radioactivity concentration measurements in air and precipitation samples collected along the slopes of Mauna Loa volcano in Hawaii have been examined in relation to vertical profiles of temperature and humidity in the atmosphere across the trade wind inversion. The gradient of radioactive aerosol concentration in the air with height is related strongly to the humidity profile and the character of the trade wind inversion. The concentration increased with height across the trade wind inversion in contrast to aerosols of terrestrial origin whose concentration in air decreased with height. The concentrations in rainfall generally decreased with height, except for an anomalous result at 2250 m, just below the trade wind inversion. At this altitude, the gross radioactivity concentration increased while the ^{90}Sr concentration decreased. The ratio of the gross beta concentration in air and rain gives a parameter with dimensions of mixing ratio, which may be of potential use in determining rainout efficiencies. (auth)

20184 (SZS-13/66) AKTUELLE PROBLEME DES STRAHLENSCHUTZES. STRAHLENSCHUTZMEDIZIN ALS WISSENSCHAFTLICHE GRUNDLAGE AERZTLICHEN HANDELNS IM STRAHLENSCHUTZ. (Actual Problems of Radiation Protection. Radioprotective Medicine as Scientific Principles of Medical Affairs in Radiation Protection). Sitzlack, G. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Dec. 1966. 22p. (In German). Dep. mn.

Radiation protection represents a complex field covering medical-biological, physical-technical, and radiochemical problems. All measures of radiation protection are based on the radiobiological-medical interpretation of the entire radiation situation that can be recorded by measurements. The problems of research and control connected therewith are summarily stated, explaining the tasks of the institution that is responsible for radiation protection in the German Democratic Republic. (auth)

20185 (UCRL-50163(Pt.1)) PREDICTION OF THE MAXIMUM DOSAGE TO MAN FROM THE FALLOUT OF NUCLEAR DEVICES. I. ESTIMATION OF THE MAXIMUM CONTAMINATION OF AGRICULTURAL LAND. Tamplin, Arthur R. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 3, 1967. Contract W-7405-eng-48. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A semi-empirical approach toward estimating the maximum contamination of agricultural land by radionuclides produced by nuclear devices is presented. It is based upon the maximum fallout levels observed subsequent to all previous tests of nuclear devices and applies to cloud travel times or fallout arrival times ranging from 1 to 50 hr and beyond. (auth)

20186 (AEC-tr-6467/1) LABOR HYGIENE AND INDUSTRIAL SANITATION. A Collection of the Principal Official Publications. Part I. Yanin, L. V. (ed.). Translation of Sbornik Vazhneishikh Ofitsial'nykh Materialov po Voprosam Gigieny Truda i Proizvodstvennoi Sanitarii, Gosudarstvennoe Izdatel'stvo Meditsinskoi Literatury, Moscow, 1962. 284p. (IPST-Cat.-1264/1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Various aspects of the organization of industrial sanitary inspection are discussed. Laws concerning labor protection and public health are presented. Regulations and instructions for general sanitary specifications are stated. Tables are presented showing permissible concentrations of thorium, uranium, toxic gases, vapors, and dust in the air of work premises; permissible concentrations of hazardous substances in water; and permissible concentrations of harmful substances in the atmosphere of populated areas. (H.L.W.)

20187 (NSJ-tr-66) RADIATION CONTROL IN ENTERPRISES. THE CASE OF THE TOKAI REFINERY OF ATOMIC FUEL CORPORATION. Maruyama, Masatomo. Translated from Genshiryoku Kogyo, 11: No. 3, 65-74; 79(1965). 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $2.60 fs, $1.01 mf.

Activities related to personnel protection at the Tokai Refinery of Atomic Fuel Corporation are discussed. Design of the area used for processing uranium and control measures for the area are described. A program for environs monitoring is presented. (H.G.D.)

20188 THE LET DISTRIBUTION OF THE RECOIL PROTON DOSE FROM DD AND DT NEUTRONS. Lawson, R. C.; Watt, D. E. (United Kingdom Atomic Energy Authority, Chapelcross, Scotland). Phys. Med. Biol., 12: 217-28(Apr. 1967).

The proton recoil absorbed dose from fast neutrons, measured at depth in a tissue-equivalent phantom using a Bragg-Gray type detector, is expressed as a function of the linear energy transfer, LET. The experimental distribution of dose with LET is compared with the theoretical distributions predicted by Boag for 2.5 MeV and 14.1 MeV neutrons, and by Snyder for 2.5 MeV neutrons. A comparison is made between the technique described, by which the LET distribution of dose can be determined at any point in the phantom, and the spherical proportional counter method of Rossi and Rosenzweig. The experimental curves show excellent agreement with those predicted by Boag. There is also good agreement with Snyder's curves near the front face of the phantom, but significant differences in the center and towards the back of the phantom. (auth)

20189 (D,D) AND (D,T) NEUTRON DEPTH DOSE MEASUREMENTS IN A TISSUE-EQUIVALENT PHANTOM. Lawson, R. C.; Clare, D. M.; Watt, D. E. (United Kingdom Atomic Energy Authority, Chapelcross, Scotland). Phys. Med. Biol., 12: 201-15(Apr. 1967).

The components of dose due to $^{1}H(n,\gamma)^{2}D$, $^{14}N(n,p)^{14}C$ and proton recoils were resolved experimentally for D, D and D, T neutron beams in tissue. Some modifications to the theory of Snyder and Neufeld are necessary to account for discrepancies in the proton recoil depth dose and the position of the peak thermal neutron dose. Isodose curves are presented for various beam sizes. A simple technique for measuring proton recoil quality factors with a plastic phosphor Bragg-Gray detector is described, and the quality factor for the total dose from 14 MeV neutrons is deduced as 8.5. (auth)

20190 RADIATION DOSE-RATES NEAR BONE SURFACES IN RABBITS AFTER AN INJECTION OF PLUTONIUM. Bleaney, Betty (Medical Research Council, Oxford). Phys. Med. Biol., 12: 145-60(Apr. 1967).

Rabbits, 6 weeks old, given single intravenous injections of ^{239}Pu as $Pu(NO_3)_4$, were killed at different times after injection. Undecalcified sections of femurs and vertebrae were prepared, and the dose rates determined by track counting on autoradiographs. In trabecular bone, 24 hours after injection, the ratio of maximum to minimum dose rates to stem cells outside the endosteal surface was about 3:1. All the trabecular bone surfaces showed a deposit of plutonium. At 16 weeks after injection about

one-fifth of the trabecular bone surface still showed a significant dose rate, and only a small percentage of the surface had no plutonium deposit, even though nearly all the trabecular bone had been formed since injection. Since most of the endosteal bone surface is trabecular bone, a large volume of stem cells and marrow cells is irradiated by these deposits. There was also a significant dose rate due to plutonium in the marrow. (auth)

20191 ^{137}Cs IN THE HUMAN HAIR. Popov, D. K.; Plotko, E. G.; Ibatullin, M. S.; Ramzaev, P. V. Med. Radiol., 12: No. 2, 27-31(Feb. 1967). (In Russian).

The authors elucidated the possibility of determining the levels of ^{137}Cs in the human organism by analyzing the hair for conditions of chronic penetration of the isotope due to global fallout. On two groups of persons with an essential difference (10–100 times) of ^{137}Cs content in the organism, corresponding differences in the isotope level in the hair were found. The ratio of specific activities (in Curie/kg) of the body and hair proved to be equal to 3.6. Individual differences in the ratio comprise ±86%. (auth)

20192 DETERMINATION OF THE PERCENTAGE DEPTH DOSE OF ROENTGEN AND GAMMA-RADIATION. Golovan, V. A.; Efremova, E. F.; Kozlova, A. I.; Krongauz, A. N.; Shagimardanov, N. Sh. Med. Radiol., 12: No. 2, 3-8(Feb. 1967). (In Russian).

An analysis and generalization of experimental data on the distribution of depth doses of roentgen and gamma-radiation in a tissue-equivalent phantom helped to evolve formulas for calculating relative depth doses in a homogenous medium (auth)

20193 COMPUTER-BASED EXTERNAL BEAM RADIOTHERAPY PLANNING. II. PRACTICAL APPLICATIONS. Cooper, R. E. M.; Worthley, B. W. (Univ. of Adelaide). Phys. Med. Biol., 12: 241-9(Apr. 1967).

A method of utilizing a high-speed digital computer for the generation of accurate external beam radiotherapy dose distributions is described. Details of the system, which includes corrections for non-normality of incidence and inhomogeneous tissue, are given. A programme has been written which incorporates all these features together with automatic calculation and true-to-scale print-out of depth doses. (auth)

20194 COMPUTER-BASED EXTERNAL BEAM RADIOTHERAPY PLANNING. I. EMPIRICAL FORMULAE FOR CALCULATION OF DEPTH-DOSES. Worthley, B. W.; Cooper, R. E. M. (Univ. of Adelaide). Phys. Med. Biol., 12: 229-40 (Apr. 1967).

An empirical method is given which may be used for the automatic computation of isodose charts by a high-speed digital computer with an attached digital plotter. The basic physical data are derived from published tissue-air ratio tables. The procedure is valid for the principal axes of rectangular fields, with and without wedges of constant slope, for beams from a 4 MV linear accelerator, from ^{60}Co units, or in the H.V.T. range 1 to 3 mm Cu for diaphragm-limited fields. For oblique incidence of radiation on a surface of arbitrary shape, a correction procedure equivalent to the "effective S.S.D." method is used, and a procedure is given to estimate the approximate depth-dose in the presence of internal inhomogeneities of the body. (auth)

20195 AN ANALOGOUS ELECTRON COMPUTER ("DOSE") FOR CALCULATING THE DOSE FIELDS. Golovan, V. A.; Dmokhovskii, V. V.; Efremova, E. F.; Kozlova, A. I.; Krongauz, A. N.; Ushakov, V. B.; Fadeeva, M. A.; Frolova, A. V.; Tsybulskii, B. A.; Shagimardanov, N. Sh. Med. Radiol., 12: No. 3, 3-8(Mar. 1967). (In Russian).

An analogous electron computer used for calculating the dose fields in multifield and rotation methods of irradiation is described. The use of computers for calculating the distribution of dose fields significantly shortens the time required for choice of irradiation technique by permitting assessment of several plans for the treatment of each patient. Use of the Dose machine is illustrated by several calculations. Dose fields obtained with the aid of the Dose machine are compared with those obtained by other methods. (auth)

20196 LINEAR PROGRAMMING IN THE PLANNING OF TELEGAMMATHERAPY OF BRONCHOGENIC CANCER. Dyatlova, N. N. Med. Radiol., 12: No. 3, 8-12(Mar. 1967). (In Russian).

Based upon studies of the literature on radiation injuries of the chest, permissible doses were determined for the healthy lung, spinal cord, skin, and cardiac muscle. Maximum permissible doses were derived for projected hot areas of the dose field in tumorous areas. Application of an electron computer for dosimetry using source-skin distances of 35 and 60 cm is described. (TSS)

20197 THE DISTRIBUTION OF DEPTH DOSES ALONG THE AXIS OF THE BEAM IN CLINICAL DOSIMETRY. Sinitsyn, R. V. Med. Radiol., 12: No. 3, 13-20(Mar. 1967). (In Russian).

A new method is presented for calculating important dosimetric characteristics of radiotherapy. Integral dose and effectiveness coefficients are determined by the value of axial intensity of depth doses. By use of tables the proposed method allows calculation of integral doses in different regimens of irradiation. (TSS)

20198 USE OF A TRANSIT DOSE CHAMBER FOR DETERMINING THE TUMOR DOSE IN ROTATION IRRADIATION. Ratner, T. G.; Nikulin, Yu. P.; Bibergal, A. V. Med. Radiol., 12: No. 3, 20-4(Mar. 1967). (In Russian).

Design and use of a transit dose chamber for determining the focal dose during rotational γ-therapy of centrally located tumors are described. (H.G.D.)

20199 CALCULATION OF THE DOSE DISTRIBUTION IN HETEROGENEOUS MEDIA. Lur'e, A. I. Med. Radiol., 12: No. 3, 24-8(Mar. 1967). (In Russian).

A method is presented for calculating the dose distribution close to the division of heterogeneous media. The technique is based on the theory of reverse scattering of radiation. Formulas for dose intensity at any point in a heterogeneous medium consisting of 11 homogeneous layers and coefficients determining the value and correction sign at the border of media division are included. A special case of the method is presented that uses formulas for calculating the dose distribution of the flow of photons emanating from the medium into the air and accounts for buildup. (auth)

20200 THE ESTIMATION OF THE DOSE LOADINGS IN EXPONENTIAL LAY OF ELIMINATION WITH CONSIDERATION OF PHYSICAL DECAY. Malykhin, V. M.; Shamov, V. P. Med. Radiol., 12: No. 3, 65-9(Mar. 1967). (In Russian).

The expressions for analytical calculation of the content of the activity of q (t) and the absorbed dose in osteotropic elements on the basis of an exponential model with due consideration to decay are presented. Initial data for estimation according to the formulas are the rate of radioisotope penetration into the organism (q_1 – activity of the ration), activity of excretion (q_1), or the isotope content in the organism at the time when t_2 is noted. The values of the dose for two variants of isotope penetration into organism are presented: for regular penetration up to the time of t_2, and for the restricted time of t_1 contact that terminated earlier than the time of observation. Depending on initial data, it was deemed possible that by means of the described formulas, the dose loadings for important cases could be determined. (auth)

20201 HAZARDS OF LASER RADIATION: MECHANISMS, CONTROL, AND MANAGEMENT. Litwin, Martin S. (Veterans Administration Hospital, West Roxbury, Mass.); Fine, Samuel; Klein, Edmund; Fine, Ben S.; Raemer, Harold. Amer. Ind. Hyg. Ass. J., 28: 68-75(Jan.-Feb. 1967).

Analysis of biological studies indicate the factors responsible for hazards associated with laser systems: laser radiation and its interaction with the biological system, pumping source, high voltage and current required for operation of a laser system, and environment in which this system is used. Short-term and long-term hazards associated with the beam are dependent on the properties of the radiation and those of the biological system. Hazards associated with flashtubes must be considered, particularly since misfire or accidental firing can occur. Long-term effects on the eyes due to either a single insult or to cumulative subthreshold insults are not yet known but continue to present a potential hazard. Hazards to the skin must also not be neglected in continued testing. (auth)

20202 CAPACITY OF LEAVES ON TREES AND BUSHES TO RETAIN GLOBAL RADIOACTIVE FALLOUT. Yagovoi, P. N. Gig. Sanit., No. 2, 32-7(Feb. 1967). (In Russian).

The results of radiometric and radiochemical investigations of the leaves of trees and bushes show that the capacity of the leaves to retain global radioactive sediments is inversely proportional to their ash contents. Qualitative indices for assessing the capacity of leaves to accumulate artificial radioisotopes and evaluates the investigated sorts of trees and bushes by means of these indices. The findings prove the leaves of trees and bushes to retain cesium-137 and strontium-90 better than cerium-144. (auth)

20203 RADIATION MONITORING WITH NUCLEAR EMULSIONS ON MISSION GEMINI IV AND V. Schaefer, Hermann J.; Sullivan, Jeremiah J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Aerospace Med., 38: 1-5(Jan. 1967).

On Gemini type missions the bulk of the radiation exposure of the astronauts is due to trapped protons picked up in the South Atlantic Anomaly. Although the exposure remained around the 50-millirad level during the four-day mission (Gemini IV) and around the 100-millirad level during the seven-day mission (Gemini V), a detailed analysis of the proton energy spectrum seems of special interest. Track and grain count evaluation of nuclear emulsion carried by the astronauts within their space suits and helmets

shows that this spectrum is a continuum from zero to about 400 MeV kinetic energy with a broad maximum. Since a large part of the flux is of low penetrating power, the radiation level within the capsule sensitively depends on local shield geometry showing dose rate variations of 20 per cent at opposite corners of the same film sheet. A similarly strong variation must be assumed to exist for the depth dose within the astronauts' bodies, with dose dropping steeply to values lower than the aforementioned surface dose levels found in the emulsions. (auth)

20204 CALCULATION OF RADIATION DOSE FROM A CLOUD OF RADIOACTIVE GASES. Arnett, L. M. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Appl., 3: 217-21(Apr. 1967). (DP-MS-66-25).

Formulas are developed for the calculation of the whole-body γ radiation dose from a cloud of radioactive gases. The complexity of the formulas is greatly reduced by the simplifying assumption that the cloud does not change in size and shape during the time that the receptor is exposed to radiation. For most cases of interest, the numerical solutions based on this assumption are nearly identical with more detailed solutions. The formulas were programmed for computer solution so that large parametric studies are possible in an hour or two of machine time. The numerical solutions can be displayed as a contour map or an isometric drawing as a function of cloud size and shape. When lines that are functions of meteorological conditions and distance from the release point of the cloud are added to such a display, the details of the solution are graphically presented to provide a very clear visual comprehension. (auth)

20205 CALCULATION OF THE DOSES IN NUCLEAR MEDICINE AND IN RADIOPROTECTION. STUDY OF AN EXAMPLE: RADIOACTIVE I. Delpla, M. J. Radiol., Electrol. Med. Nucl., 47: 783-7(Dec. 1966). (In French).

The possibility of calculating the numerical value of the radiation dose necessary to destroy the function of a normally functioning thyroid gland by use of ^{131}I was investigated. The methods used for calculations are outlined and the calculation validity is discussed. (J.S.R.)

20206 PROMOTION OF RADIOISOTOPE EXCRETION. Strain, William H. (Univ. of Rochester, N. Y.); Danahy, Daniel T.; O'Reilly, Richard J.; Thomas, Martin R.; Wilson, Robert M.; Pories, Walter J. J. Nucl. Med., 8: 110-16(Feb. 1967).

Manganese disodium EDTA and zinc disodium EDTA, two metal chelates widely used as agricultural products, were shown to promote the excretion from rats of the corresponding radioisotopes ^{54}Mn and ^{65}Zn. The effect is greatest the sooner the metal chelates are administered after injection of the radioisotopes. The principle of administering metal chelates to promote the excretion of radioisotopes corresponding to the metal of the chelate is broad. Further work will give greater understanding of the biological factor governing the metabolism of radioisotopes. This work will both increase the scope of nuclear medicine and provide treatments for nuclear accidents. (auth)

20207 PSYCHOLOGICAL ASPECTS OF THE PREVENTION OF ACCIDENTAL IRRADIATIONS. Sivadon, Paul. Euratom Bull., 6: No. 1, 6-9(Mar. 1967).

Psychological factors playing a role in radiation accidents are the personality of the subject, the conditions in which he received his training and information, and his relations with the work group. The first few moments of training upon starting work, the attitude toward the job and the anxiety which it causes, and the influence of inaccurate information are of particular importance. Personality tests may be used during recruitment selection in order to keep inflexible subjects out of jobs which may require rapid adaptation. In this way it is also possible to eliminate accident-prone subjects. It is also very important to build up and maintain safety behavior. Safety habits must be learned early and provision must be made for their reinforcement by a feed-back system which provides a perceptible response to the prescribed routine movements. (H.L.W.)

20208 TECHNIQUE IN TESTING RADIUM SOURCES FOR LEAKAGE. Benson, James S.; Fetz, Richard H. (Dept. of Health, Education, and Welfare, Washington, D. C.). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 99: 479-81(Feb. 1967).

The jar method was used to leak-test radium sources in 21 hospitals in Georgia. A total of 3,388 milligrams of radium contained in 725 sources was leak tested over a 9 month period. Of the 21 hospitals visited, 10 had sources indicating leakage. No exposure higher than 30 mR per month was indicated by the wrist and waist film badges worn by surveyors during the testing period. The Georgia Department of Health is continuing the use of the jar method, and it is now being used by personnel in several other State health departments. (auth)

20209 SINGLE-FILM TECHNIC FOR DETERMINING THE CO-ORDINATES OF RADIATION SOURCES IN IMPLANT DOSIMETRY. Rao, U. V. Gopala; Rollo, Frank D.; Digel, Joseph (Johns Hopkins Medical Inst., Baltimore). Radiology, 88: 365-8(Feb. 1967).

A new method of determining the coordinates of radiation sources in implant dosimetry is described. The method consists in taking two views, one a direct anteroposterior and the other an oblique 45° view on the same film. All the three coordinates can be obtained by simple ruler measurement without any calculation. (auth)

20210 DETERMINATION OF VOLATILE COMPOUNDS OF FISSION-PRODUCT IODINE. Smith, S. R.; West, D. L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Appl., 3: 43-5(Jan. 1967). (DP-MS-66-17; CONF-650902-12).

Organic iodides presumably derived from interaction between fission product iodine and process solvent, were detected and identified by gas chromatography in the exhaust air from the Purex process at the Savannah River Plant. Three of ten peaks obtained were tentatively identified as alkyl iodides by the behavior of the detected compounds and the relative response of an electron absorption detector vs a flame ionization detector. (auth)

20211 BODY BURDEN OF ^{137}Cs IN JAPAN. Iinuma, T. A. (National Inst. of Radiological Sciences, Chiba, Japan); Uchiyama, M.; Nagai, T.; Ishihara, T.; Saiki, M.; Yamagata, N. Nature, 214: 133-5(Apr. 8, 1967).

A monthly monitoring programme was instituted, covering ^{137}Cs and other radioisotopes, employing plastic scintillator whole body counters. The counter and monitoring technique are described. The counter was calibrated for ^{137}Cs and ^{40}K. A sodium iodide spectrometer was used to check that there were no other radionuclides in the body. Changes in body content of ^{137}Cs for the period July 1963 to March 1965 are tabulated; a marked increase was indicated. The content of ^{137}Cs per unit body weight was dependent on age. Ratios of $^{137}Cs/^{40}K$ were also measured; an apparent corelation in distribution was observed. The studies included investigation of the effect of different dietary intake on the body burden of ^{137}Cs; effects were small. Differences in body burden were much larger for ^{137}Cs than for ^{40}K; this appears due to metabolic differences. Differences in individual biological half-lives of caesium may also explain lasting individual differences in ^{137}Cs burden. Potassium is an essential element for living organisms, and its amount is maintained at a constant level. (UK)

20212 GERMAN STANDARDIZATION IN RADIOLOGICAL TECHNIQUES, ITS ORIGIN AND DEVELOPMENT. Graf, Herbert (Siemens-Reiniger-Werke AG, Erlangen, Ger.). Strahlentherapie, 131: 568-76(Dec. 1966). (In German).

The Standardization Office of the German Radiological Society in retrospect and its achievements (1927–1940) are discussed. Brief remarks concerning the German Radiation-Standardization Office and the work accomplished by the standardization committee of the electron-medical department of the Electro-industry Economic Group (1940 to 1945) are given. A description of the founding of the Committee on Radiological Standards of the German Standardization Commission, in cooperation with the German Radiological Society in 1951, its structure and its development up to the present time is also given. (auth)

20213 FILTER ANALYSIS FOR DETERMINATION OF PERSONAL DOSE WITH FILM BADGES. Makiola, Klaus (St. Georg Allgemeinen Krankenhauses, Hamburg). Strahlentherapie, 131: 536-51(Dec. 1966). (In German).

Based on filter analysis, a computer program was worked out for evaluating results obtained with film badges, which were used for x- and γ-ray exposures, in order to determine personnel doses. The hard factor curve, which gives the wavelength dependency of the film used, can be resembled in a first approximation by a Gaussian error distribution curve within a photon energy range between about 20 kev up to several Mev. No systematic errors are involved in the determination of the radiation component. Several examples are used to demonstrate this method. The uncertainty in experimental results and the errors caused by the approximation average 20%. A lower error can be obtained by the use of copper filters of equal thickness. Another paper, concerning the automatic data processing of the personnel dose determination by means of film badges as obtained in the Radiation Office of the General Hospital of St. George in Hamburg, will be published. (auth)

20214 ACCIDENT FOCUSES ON RADIUM PROBLEM: ARE STRICTER REGULATIONS NEEDED? Glos, Margaret. Nucleonics, 25: No. 1, 60-3(Jan. 1967).

Regulations concerning the use of Ra in the U. S. are reviewed. It is pointed out that state regulatory agencies are responsible for the regulation of Ra uses, with assistance from the Public Health Service. A recent incident of Ra contamination resulting from a hairline crack in a 50-mg nasopharyngeal Ra applicator is de-

scribed that resulted in the contamination of over 200 homes, the closing of an entire medical center building for over 2 weeks and some parts of the building for over a month, and a cost of about $30,000 for decontamination of the building. It is emphasized that Ra sources should be re-encapsulated every 5 to 6 yr, since most of them leak after this period. It is suggested that the use of suitable radioisotopes, such as ^{131}Cs, ^{90}Sr, ^{192}Ir, and ^{192}Au, as radiation sources as a substitute for Ra, would reduce the contamination hazard. (C.H.)

20215 TISSUE CURRENT-TO-DOSE CONVERSION FACTORS FOR NEUTRONS WITH ENERGIES FROM 0.5 TO 60 MeV. Irving, D. C.; Alsmiller, R. G. Jr.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Instrum. Methods, 51: 129-35(1967). (ORNL-P-2749).

To assist in the evaluation of the hazard associated with exposure to high-energy neutrons, a Monte Carlo computer program was used to calculate the energy deposition as a function of depth in a 30-cm-thick infinite slab of tissue resulting from neutrons incident on the slab at energies up to 60 MeV. The program treated nonelastic and elastic interactions, including evaporation processes and nuclear recoils. Cases of both normal and isotropic incidence were calculated for neutrons of 0.5, 2, 10, 18, 30, and 60 MeV. From these data, current-to-dose conversion factors were extracted for the average whole-body dose, the dose at a 5-cm depth, and the maximum dose. A set of quality factors (QF's) was adopted for transforming rad dose to rem dose. (auth)

20216 EXPLOSIVE LENS FLASHBLINDNESS PROTECTION SYSTEM. Scott, D. D.; Snider, L. M. (Johns Hopkins Univ., Silver Spring, Md.). APL (Appl. Phys. Lab.), Tech. Dig., 5: 11-16(July-Aug. 1966).

Nuclear detonations emit thermal energy which may produce permanent chorioretinal damage to the eyes or a temporary loss of vision, flashblindness. Since the loss of vision, for even a few seconds, may be disastrous to a high-performance aircraft pilot, he must be provided eye protection. This development of an explosively actuated protective system designed to minimize the effects of flashblindness and to prevent permanent thermal injury to the eyes is described. This system consists of a Navy APH-5 flight helmet, modified to support the ELF lens (goggle); a sensing device used to detect a nuclear-detonated, electromagnetic radiated signal; a battery-operated discriminator unit (the trigger), which is connected electrically to the lens and sensor. Specifications for the ELF system are listed. The earliest detectable nuclear detonation signal used for triggering occurs in the early microsecond region in the form of an electromagnetic emission in the visible spectrum and an electromagnetic pulse (EMP) in the rf band. In the optical sensing system, a Si detector cell is located in the forehead region on the helmet surface, whereas the EMP system uses a painted Ag epoxy antenna and ground plane. The triggering device processes the detected signal and initiates a firing pulse to the ELF goggle, by releasing a stored capacitor charge if discrimination shows the detected signal to be from a nuclear detonation. The detonators produce a velocity impulse (7000 m/sec) to ignite a mild detonating fuse. The conceptual ELF lens design evaluation covers several techniques for occluding the lens systems, which are described. Functional firing tests have indicated satisfactory time-density performance, obtaining optical density 3.0 in 200 μsec or less over an operational temperature range from 30° to 120°F. The goggles have maintained their protective closure for a min period of 10 sec at optical density of 4.0 or greater. (BBB)

20217 GENERAL GUIDELINES FOR EVALUATION OF DIAGNOSTIC RADIATION INJURIES. Pape, Rudolf (Roentgeninstitut, Vienna). Radiol. Austr., 16: 177-81(1966). (In German).

The gonadal dose received during thoracic fluoroscopy varies considerably with the voltage, exposure time, and current used. At 70 kv, 2 mm Al, and 2.5 ma, a 2-min exposure gives a gonadal dose between 1.5 and 3.2 mR. For 90 kv, with 2, 3, and 6 mm Al, and 48-sec exposure, the ranges for gonadal exposure are 0.25 to 0.5, 0.05 to 0.1, and 0.03 to 0.05 mR, respectively. When a television photo is taken the male gonadal dose is 0.06 mR, and the female gonadal dose is 0.12 mR. In males the values are 0.45 and 0.17 for lens or mirror optics, and for females range from 1.5 to 3.0 and 0.2 to 0.4 mR, respectively. Normal daily background gonadal irradiation is 0.3 mR. In studies of gonadal irradiation received from studies made on other portions of the body the % is least for studies of the extremities, such as head, neck, or thorax, and amounts to 1 or 2%. It is 1 to 5% for studies of gallbladder, stomach, duodenum, or spine. For intestinal, urogenital, or pelvic studies gonadal fractional exposure is 1 to 5% for males and ~10% for females. For studies of the hip region in male infants without protection the gonads receive 100% of the dose, but female infants receive 50%. If protective shields are used, the gonadal dose can be reduced to 5% of the total administered to the hip area. Generally, during studies of the extremities and upper parts of the body the gonadal dose can be measured in terms of mR or fractions of a mR, in studies of the upper abdominal area they are ~ one order of magnitude greater, and 2 orders of magnitude greater during examinations of the lower abdomen. The values are less in males than in females and somewhat less in children than in adults. (BBB)

20218 FURTHER OBSERVATIONS ON THE RADIOPROTECTIVE EFFECT OF PANTOTHENIC ACID. Szorady, I.; Gazdag, I.; Kocsor, S. (Staedtische Kinderkrankenhaus, Szeged). Naturwissenschaften, 53: 527(1966). (In German).

One group of Wistar rats was treated with pantothenic acid for a week, then given a week's treatment with physiological sodium chloride solution, and then exposed to whole-body x radiation of 900 R. A second group was treated with pantothenic acid for a week and then exposed to the whole-body irradiation. The third group received physiological sodium chloride solution for two weeks before whole-body irradiation. The results showed that the pantothenic acid gave a radioprotective effect. The epithelial protective effect of the pantothenic acid is still not pronounced. Pantothenic acid is only of limited effect on the changes in the blood picture resulting from the radiodamage to the bone marrow. (J.S.R.)

20219 DOSE-SURVIVAL RELATIONSHIP FOR IRRADIATION OF EPITHELIAL CELLS OF MOUSE SKIN. Withers, H. R. (Mt. Vernon Hospital, Northwood, Eng.). Brit. J. Radiol., 40: 187-94(Mar. 1967).

A technique is described whereby a dose-survival relationship for skin epithelial cells was established using 29 kVp x rays. Between doses of 900 and 2,300 rads the relationship may be described by a survival curve having a value for D_0 of 135 rads. The effect of a dose of radiation on skin is expressed as the number of cells surviving per unit area and not as the usual surviving fraction because it is not possible to count accurately the numbers of clonogenic epithelial cells per square centimeter of unirradiated skin. For this reason also, the origin of the survival curve and the related extrapolation number cannot be determined. Gross responses of skin are discussed in the light of epithelial cell survival characteristics. It is unlikely that mouse skin will ulcerate if more than 10 to 20 cells per square centimeter survive irradiation. It is also unlikely that there are any anoxic cells in the epithelium of skin or hair follicles of anesthetised air-breathing mice. (auth)

20220 APPLICATION OF THERMOLUMINESCENT PHOSPHORS IN DOSIMETRY PROBLEMS IN RADIOTHERAPY AND RADIOBIOLOGY. Naylor, G. P. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol., 40: 170-6 (Mar. 1967).

The advantages and disadvantages of lithium fluoride dosimetry in a number of practical applications can, in the light of two years' experience, be summed up as follows: the main advantages are the small size and the rugged nature of the dosemeter. On the other hand, all measurements must be made as comparisons between the measuring phosphor and phosphor from the same batch that has had a known irradiation to a similar dose, from similar radiation, at about the same time; and fading of the response takes place in the first two days after irradiation and must be eliminated by a waiting period or by pre-heating before read-out. Successful applications include inter-center comparison of the rad, measurements on the skin and in body cavities during radiotherapy, uses in conjunction with radiobiological research, contamination measurement in fast-neutron beams and in finger badges used for radiation protection measurements. The dosemeter is useful, reliable and sufficiently accurate for such special applications provided that it is used with a knowledge of its properties and responses. (auth)

20221 APPARATUS FOR DISPENSING RADIOACTIVE SOLUTIONS. Owen, G. M. (Velindre Hospital, Cardiff, Wales). Brit. J. Radiol., 40: 143-4(Feb. 1967).

An automatic system is described that was designed to obviate manual handling of a radioactive source used for the calibration of personnel monitoring films. Electronic control of the system gives accurate timing and extremely reproducible exposures. Several fail-safe devices are incorporated and personal exposure to ionizing radiation reduced to a minimum. The system is applicable to any operation involving the exposure of a radioactive source for a given time. (auth)

20222 PHYSICAL IDEAS AND QUANTITIES IN THE DOSIMETRY OF IONIZING RADIATION. Fraenz, Hans (Physikalisch-Technische Bundesanstalt, Brunswick). Strahlentherapie, 131: 270-7(Oct. 1966). (In German).

The relations between physical quantities and units, which are

defined in the German Journal of Standards and in the Recommendations of the International Commission on Radiological Units and Measurements and used describing radition sources, radiation fields, and the interaction between ionizing radiation and matter, as well as their relations to optic quantities are discussed. (auth)

20223 DESCRIPTION OF THE RADIATION FIELD BY SEPARATING PRIMARY AND SCATTERED RADIATION. I. RELATIVE DOSE DEPTH DISTRIBUTION IN THE CENTRAL BEAM FROM ^{60}Co FIELDS. Schoknecht, Guenter (Auguste-Viktoria-Krankenhauses, Berlin). Strahlentherapie, 131: 311-18 (Oct. 1966). (In German).

An equation derived earlier for the relative depth dose distribution along the central beam can be interpreted as the dose distribution of the primary radiation multiplied by a scattering correction factor. This interpretation is supported by other considerations, and in connection with recent measurements leads to a general equation for the depth dose distribution of ^{60}Co radiation fields. The equations were evaluated with an S 2002 computer and compared with experimental results. Deviations obtained are, on the average, below 5%. (auth)

20224 NUCLEAR ENERGY TO IMPROVE ENVIRONMENTAL HEALTH. Holmquist, C.-E. (Swedish State Power Board, Stockholm). Tek. Tidskr., 97: No. 3, 49-50(1967). (In Swedish).

Accidents are the leading cause of loss of life in fifty percent of all deaths in the western countries. Despite the urgent need to reduce this heavy fall of human life the safety concepts used in nuclear energy (and space medicine) are not applied elsewhere in the community. On the contrary, the nuclear power industry is the most restricted of all branches of industry and is forced to build outside urban areas. The air pollution menace could be greatly reduced if this emission free source of energy were allowed where it is needed. (auth)

20225 LITERATURE STUDY OF THE METHODS AND PROCEDURES FOR DECONTAMINATION OF MILK CONTAMINATED WITH RADIOACTIVITY. Knoop, E.; Buchheim, W. (Bundesforschungsanstalt fuer Milchwirtschaft, Kiel). Kiel Milchwertsch. Forschungsber., 17: 411-39(1965). (In German).

A review (80 references) of methods available for removal of radionuclides, such as ^{140}Ba, ^{134}Cs, ^{131}I, ^{42}K, and ^{85}Sr, from in vivo contaminated milk is presented and pilot plant installations for research in this field are described. The methods discussed and evaluated were batch procedures with ion exchange resins, fixed-bed synthetic ion exchange procedures, the Higgins ion exchange process, ion exchange materials in combination with chemically treated bone ash, electrodialysis, and decontamination using calcium phosphate. The study revealed that more than 90% of the contamination in milk could be removed without alteration in the nutritive and organoleptic properties of milk. (TSS)

20226 SOMATIC CHROMOSOME ABERRATIONS INDUCED BY HUMAN WHOLE-BODY IRRADIATION: THE "RECUPLEX" CRITICALITY ACCIDENT. Bender, M. A.; Gooch, P. C. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Radiat. Res., 29: 568-82(Dec. 1966). (ORNL-P-1859).

We have measured the frequencies of chromosome aberrations in samples of peripheral leukocytes obtained periodically from three men exposed to acute, whole-body, mixed γ-ray and fission-neutron radiation during the Recuplex criticality accident which occurred on April 7, 1962, at Hanford, Washington. The first samples were obtained 4 hours after the irradiations, and the rest at intervals over the following 2 years. Physical dose estimates have been made, ranging from 12 rads for the least exposed man to 47 rads for the most heavily exposed man. Chromosome aberrations of the expected types were seen in the first samples from all three men. Although the aberration yields were low, their frequencies are consistent with expectations based on the physical dose estimates and the coefficients of aberration production which have been determined by irradiation of whole-blood samples in vitro with x rays and with fission neutrons. Measurement of chromosome aberration frequencies thus appears to be a practical method of biological dosimetry in the case of acute, whole-body exposures; although absolute agreement with physical dose estimates may not be perfect, especially at very low doses, the method offers a quick ball-park estimate based on biological effect. The data suggest that valid estimates may be made from leukocyte samples obtained many days, and perhaps even weeks, after irradiation. As expected, the frequencies of aberrations dropped after several weeks, but some aberrations were still seen in the 2-year samples. (auth)

20227 SPECIALIZED PROTECTIVE CLOTHING DEVELOPED AT THE SAVANNAH RIVER PLANT. Croley, J. J. Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Amer. Ind. Hyg. Ass. J., 28: 51-5(Jan.-Feb. 1967). (CONF-660504-1).

The Savannah River Laboratory has improved the design of the following articles of protective clothing: plastic suits supplied with cooled air, air-supplied welder's hoods, cloth coveralls, laboratory coats, and shoe covers, plastic suits for rescue teams, and tear-away sleeves for work with moving machinery in areas where protective garments are required. (auth)

20228 HEALTH PHYSICS. PRINCIPLES OF RADIATION PROTECTION. Rees, D. J. Cambridge, Mass., Massachusetts Institute of Technology, 1967. 249p. $12.95.

Basic concepts of atomic physics and radiobiology are reviewed as an introduction to the philosophy of radiation protection. The properties of x rays, α particles, β particles, and neutrons, and their interactions with matter are discussed. Radiation units and dose equivalents are defined, with particular reference to radioisotope and x ray exposure. Both the genetic and somatic effects of ionizing radiation are discussed. The basic standards of radiation protection, including the concept of the maximum permissible dose, are presented. Protective measures against both internal radionuclides and external γ sources are described. Instruments used for the dosimetry of radiation in individuals and in the environment are discussed. The basic concepts of interest in the design of a radioisotope laboratory are included. Units used in atomic and nuclear physics and data useful for solving radiation protection problems are appended. (C.H.)

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Refer also to abstracts 19818, 20030, 20192–20198, 20216, 20315, 20332, 20382, 20383, and 20404.

20229 (ABCC–65-66) ANNUAL REPORT, JULY 1, 1965–JUNE 30, 1966. (Atomic Bomb Casualty Commission, Hiroshima (Japan)). Contract AT-49-1-GEN-72. 233p. (In Japanese and English). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Activities of the ABCC in relation to formal agreements, the Japanese Advisory Council, community relations, administration, and technical and research aspects are reported. It is pointed out that although radiation may increase or accelerate the appearance of familiar diseases, so far no new disorders have been recognized as having been induced by exposure. The effects of radiation on atomic bomb survivors in Japan have been evaluated by comparing groups that differed only in respect to the radiation dose received. The core of the population studied consisted of survivors with documented acute radiation symptoms. Other groups matched by age and sex to the core group differed in that: they had no acute radiation symptoms; they suffered all of the disaster effects except radiation exposure; or they were not in the city at the time of the bombing. Progress is reported on studies performed with these groups in the areas of: morbidity, mortality, specific diseases and disorders, cytogenetics, growth and development, epidemiology, and dosimetry. Lists of 38 approved technical reports and 37 papers published during the report period are included. (H.G.D.)

20230 (AFRRI-SR-66-5) EFFECT OF ORAL NEOMYCIN THERAPY FOLLOWING WHOLE-BODY X-IRRADIATION OF RATS. Webster, J. B. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Oct. 1966. 17p. CFSTI $3.00 cy, $0.65 mn.

The beneficial effects of oral antibiotic treatment with neomycin following total-body x irradiation of Sprague-Dawley rats were examined. Survival times of irradiated, neomycin treated male rats were compared with those of irradiated, untreated controls. Eleven selected radiation exposures, beginning at 700 R and extending in increments to 2500 R, were used. Thirty-day lethality was also evaluated at and below exposures of 1100 R. Neomycin treatment resulted in a significant prolongation of the mean survival times of irradiated animals at exposures between 800 R and 1500 R. At exposures between 1500 R and 2500 R, a small but consistent prolongation of mean survival time resulted. For exposures between 700 R and 1100 R, the 30-day lethality was consistently lower for the neomycin treated rats. It is suggested that postradiation treatment with oral neomycin, administered every 12 hours, can effect an increase in the mean survival time of whole-body x-irradiated rats. (auth)

20231 (COO–1391-9) ISOLATION OF A FACTOR PREVENTING X-RAY INDUCED LEUKEMIA. Progress Report, June 1, 1964–January 31, 1966. Hodes, M. E. (Indiana Univ., Bloomington). Contract AT(11-1)-1391. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Aqueous extracts of sheep spleen and the precipitate obtained after the addition of ammonium sulfate to sheep or cow serum decreased the incidence of leukemia in some strains of x-irradiated mice, when injected after exposure to x radiation. The sheep spleen extracts did not protect mice against the lethal effects of 550 to 800 R x radiation. Comparison of eluates from Sephadex columns by gel electrophoresis indicated the radiation leukemia protection factor was localized in the α- or β-globulin

fraction of serum, but commercial serum γ-globulin contained only trace amounts of the factor. Studies on the mode of action of the protective factor ruled out several possible mechanisms but did not demonstrate how the material exerts its protective action. (C.H.)

20232 (JUL-Bibl.-12) KREBS-CHEMOTHERAPEUTIKA (ZYTOSTATIKA EXKL. HORMONE UND RADIONUKLIDE). LITERATURNACHWEIS. (Cancer Chemotherapeutics (Cytostatics Excluding Hormones and Radionuclides). Literature Search). Paul, Rolf (Kernforschungsanlage, Juelich (West Germany)). Nov. 1966. 580p. (In German and English). Dep. mn.

A list of 4,186 references to literature published between 1957 and 1965 on cancer chemotherapeutics is presented. An English language index is included. (H.L.W.)

20233 (NP-16462) INTRODUCTION TO LONG-TERM BIOLOGICAL EFFECTS OF NUCLEAR WAR. Miller, Carl F.; LaRiviere, Philip D. (Stanford Research Inst., Menlo Park, Calif.). Apr. 1966. Contract N228-(62479)69928. 156p.

The state of knowledge and concepts about the reaction of biological systems to effects of nuclear weapons under nuclear war conditions, about the likely extent of damage to agricultural and wildlife ecosystems under nuclear war conditions, and about the factors involved in the long-term recovery potential of these systems after damage are summarized. In the study, an attempt was made to organize the available information for objective discussion of the subject, to outline the state of the art regarding capabilities to use the information (as well as its availability), and to make estimates of radiological effects using the available data and available (or new) computational methods. Within the reliability of the current information on the biological response of biological species to radiation exposures, the results of the study lead to the conclusion that long-term biological and ecological effects would not be so severe as to inhibit or seriously delay the national recovery after a nuclear attack similar to one of those assumed in the study. Rather, the major problems of population and biological resource survival are concluded as being associated with the short-term biological effects that would result from the exposure of all biological species to gamma radiation from fallout. The alleviation of these effects thus centers on the availability of shelter for the protection of the population and a local capability for organized efforts to recover food and water and other such resources that would be required to maintain the health of the survivors as a coherent work force in the early postattack period. This is the time period after attack when the need for knowledgeable leadership would be critical and when errors in recuperative actions would be the most likely to lead to secondary fatalities. For several assumed types of nuclear attack, the effects of the radiation from fallout in some areas of the country could result in fatal doses to all higher forms of life in exposed conditions. A few percent of the total land area of the country would likely be denuded of vegetation for a short period of time. However, the location and extent of these areas, with respect to other aspects of resource damage and economic recovery problems, are such that the ecological consequences of the biological damage in these areas could have little or no influence on national recovery. Essentially all of the economically important agricultural land is recoverable within the first year after attack for the case in which the existing shelter system is used. (auth)

20234 (NYO-2182-9) THREE YEAR SUMMARY [ON EVALUATION OF POTENTIAL SCANNING AGENTS IN BRAIN TUMORS], JANUARY 1964-DECEMBER 1966. McQueen, J. Donald; Mego, John L. (Maryland Univ., College Park). Contract AT(30-1)-2182. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Potential radioisotope-labeled materials for use in scanning brain tumors were evaluated in tumor-bearing mice. Emphasis was placed on the study of mechanisms by which tumors take up protein macromolecules. A comparison was made of the uptake of labeled macromolecules by tumors and liver using human serum albumin or ovalbumin labeled with ^{131}I and other macromolecules, such as poly-L-lysine, polyvinyl-pyrrolidone, and other endogenous proteins labeled with ^{74}As-arsanilic acid. The uptake of smaller proteins, such as ^{131}I-ribonuclease, ^{74}As-arsonoazolysozyme, ^{74}As-arsonoazotrypsin, and ^{74}As-arsonoazoribonuclease and of ^{131}I-polyvinylpyrrolidone and ^{125}I-ribonucleic acid, was also studied. Treatment of ^{131}I human serum albumin with formaldehyde or coupling with diazotizable materials did not improve the differential uptake by tumors although results suggest that it may be possible to treat labeled proteins chemically to produce a brain scanning agent that is rapidly cleared from the body but is taken up in tumors in relatively large quantities. Results indicate that the tumor images obtained by the use of labeled macromolecules are predominantly depictions of the extracellular space. (C.H.)

20235 (ORNL-4064) A SYSTEM FOR BIOMEDICAL DATA MANAGEMENT (DATASYS). Katzan, H. Jr. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A system for biomedical data management (DATASYS) is described that provides the research scientist with a hierarchically organized set of easy-to-use programs for use with data management problems in the fields of biology and medicine. The system provides for data calculations at a level between that provided by a desk calculator and a big computer and provides the necessary capability with a minimum of experienced computer programmers. (C.H.)

20236 (UCLA-12-612, pp 37-68) NUCLEAR MEDICINE. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

Seven cases of fatal pulmonary embolism and eight additional cases of massive but nonfatal embolism were reviewed; it was noted that small, nonlethal emboli preceded the major event by 5 days or more. Intensive heparin anticoagulation treatments for 24 to 48 hr reduced the incidence of fatal or recurrent embolization to almost zero. A technique for estimating regional pulmonary blood flow and a simple method for locating areas of impaired ventilation and perfusion with ^{131}I-macroaggregates of serum albumin was evaluated. It was found that the lung scanning technique offered a practical method for appraising regional pulmonary function and was a valuable adjunct to the chest x ray and pulmonary function tests in evaluation of chronic lung disorders. A method for preparation of colloidal ^{131}I-labeled albumin suspensions with particles 1 to 3 μ in size was outlined. A standard microwave oven, an ultrasonic agitator, and membrane filters were employed. Preliminary animal and human studies with these large colloidal radioalbumin suspensions demonstrated several advantages over those of much smaller size for use in liver-spleen scanning, liver blood flow measurement, and phagocytic function testing. Radioalbumin macroaggregates (RAMA) of narrow size distribution, 20 to 40 μ, were produced using a method similar to that described for the colloidal suspensions. Cinemicroscopic studies of the microcirculation of the RAMA and solid plastic microspheres of similar size range in the brain of rabbits were conducted. A description of the events that were observed is presented. Extensive experimental evidence of the feasibility and safety of RAMA for brain hemisphere scanning was obtained using primates. A procedure used for labeling albumin with ^{99m}Tc was outlined in detail. Approximately 30 min were required to produce a product that contained less than 5% free pertechnetate. It was shown that thymectomized animals that have been lethally irradiated and protected with bone marrow had an abnormal histologic picture in the lymphoid tissues (characterized by depletion of lymphocytes) and an abnormal immune response to sheep red blood cells (SRBC). Grafts of thymic medullary cells resulted in a return to normal histologic appearance of lymphoid tissue and immune response of SRBC. This did not occur until the graft had been populated with host lymphocytes and had been in place for at least 30 days. Mice from inbred C3H/HeJ (low leukemia) and AKR (high leukemia) strains were used to demonstrate that a tumor specific antigen in the cells of both spontaneous and virus induced leukemia produced antibodies against syngeneic leukemia cells in C3H mice. The inability of AKR mice to form cytotoxic antibodies or to be protected from syngeneic tumor cells was evidence for immunologic tolerance to the tumor cell and/or viral antigens in the high leukemia strain. Grafts of thymic tissue composed principally of epithelial reticular cells (ERC) were used to determine the role of ERC in leukemogenesis. Thymectomized mice of high and low incidence leukemia strains were used as recipients. Results showed that grafts of thymal ERC from the high leukemia strain have a leukemogenic potential in the presence of Gross virus. Iron-59 absorption measurements in patients with alcoholic cirrhosis were made. Four of six patients exhibited normal iron absorption; the other two exhibited abnormally high absorption. However, the latter had been repeatedly phlebotomized and the effects of this transient iron depletion were thought to be responsible for the high absorption that occurred. Periodic monitoring of Cyclotron personnel disclosed low level contamination of ^{7}Be, ^{54}Mn, and ^{65}Zn in one individual; a second individual showed a burden of ^{7}Be of about 0.01 μCi. Alanine labeled with ^{18}F was intravenously injected into mice; serial sacrifice studies were made at specific intervals and various organ samples were assayed to determine the organ specificity of this amino acid as compared to the sodium salt of ^{18}F. Preliminary results indicated that alanine selectively concentrated in bone, kidney, liver, pancreas, and spleen. The sodium salt of ^{18}F was noted to have even greater affinity for bone. (B.H.S.)

20237 TECHNIQUE FOR ELECTRON RADIOTHERAPY OF BRAIN TUMORS. Smirnov, R. V.; Badmaev, K. N.; Sinitsyna, A. P. Med. Radiol., 12: No. 3, 28-34(Mar. 1967). (In Russian).

A technique for treating cerebral tumors of man by means of

electrons of the energy of 10 to 20 MeV is outlined. Therapy was begun with a single dose of 50 to 100 rad per focus and was gradually raised to 300 to 400 rad per day with a weekly radiation dose of 1200 to 1300 rad. The total dose per focus was raised to 3000 to 7000 rad. Electron treatment was used to treat 23 patients with brain tumors of diverse morphological form and localization; in 11 cases bremsstrahlung energy of 25 MeV was employed. In 19 patients an improvement in general state was observed; in one case there was no improvement, and three patients died with manifestations of progressive growth. Patients seemed to tolerate electron treatment well, with the exception of patients who had tumor process localization in the posterior cranial fossa. One and two field therapy techniques for therapy were used. In one field of radiation, the radiation dose was augmented 5000 to 7000 rad. In order to spare the skin, lead screen lattices were employed. Results with this technique of electron therapy for cerebral tumors at a depth of 6 to 7 cm testified to the perspectiveness of the method. (auth)

20238 RADIUM TREATMENT OF SOFT TISSUE SARCOMAS. Kozlova, A. V. Med. Radiol., 12: No. 3, 34-8(Mar. 1967). (In Russian).

Results from combined operative intervention and radium therapy for sarcoma of different histological structure of the soft tissues in 100 patients are presented. Principal factors employed for determining both the volume of operative intervention and radium therapy were the histological structure of the tumor and the degree of differentiation of tumor cells. When tumor cell differentiation was low, the operative intervention was more extensive. In radium therapy, apart from the region of the scar, the irradiated region included surrounding normal tissues; the value of this volume was greater when the degree of tumor cell differentiation was low. The value of the radiation dose used depended on the histological structure of the tumor. Absence of relapse during a 3 yr period was observed in 52% of the patients; however, during a 5 yr period, 32% of the patients suffered a relapse. (auth)

20239 USE OF COLLOIDAL RADIOGOLD (^{198}Au) FOR POSTOPERATIVE IRRADIATION OF MILK-DUCT CARCINOMA OF MAN. Zamyatin, O. A.; Mikhalchenko, V. A. Med. Radiol., 12: No. 3, 38-43(Mar. 1967). (In Russian).

A colloidal solution of ^{198}Au was employed for postoperative radiotherapy of milk-duct carcinoma in 24 patients. Prior to radiotherapy, patients were subjected to radical mastectomy for first to third stage milk-duct carcinoma. Postoperative therapy consisted of infiltrating the region of the postoperative scar with a colloidal solution of ^{198}Au. In some cases, the ^{198}Au therapy was combined with distance γ treatment of regional metastasization areas. The technique yielded promising results. (auth)

20240 PROPHYLAXIS AND TREATMENT OF SKIN INJURIES IN RADIUM THERAPY WITH CIGEROL OINTMENT. Noskov, A. G. Med. Radiol., 12: No. 3, 55-8(Mar. 1967). (In Russian).

Patients (124) with malignant tumors of diverse locales were subjected to short-focus x-ray therapy and distant γ ray therapy. A 25% cigerol ointment (lanolin to vaseline base) was used for prophylaxis of radiation skin injuries. It was established that the ointment shortened the period of epithelization of the skin almost twofold in comparison to results in the control group. When results with the cigerol ointment were compared to results with other radioprotective agents, an indication that it was one of the most effective compounds ever to be used was noted. (auth)

20241 DISTRIBUTION OF CYSTAPHOS IN THE ORGANISM OF ANIMALS WITH TUMORS. Airapetyan, G. M.; Anorova, G. A.; Kublik, L. N.; Otarova, G. K.; Pekarskii, M. I.; Stanko, V. N.; Eidus, L. Kh.; Yarmonenko, S. P. Med. Radiol., 12: No. 3, 58-65 (Mar. 1967). (In Russian).

The dynamics of ^{35}S and ^{32}P labeled cystaphos concentration in organs and tumors of rats was investigated. It was found that the concentration of the radioprotective compound increased 2½ to 3 times in content in M-1 sarcoma of rats and 1½ times in milk-duct adenocarcinoma of mice when it was introduced into the animal by subcutaneous injection. A correlation between the optimal protective effect (survival of animals) and the period of maximum ^{35}S concentration in organs was noted. The behavior of cystaphos in an animal under experimental conditions and the possible aspects of its practical employment are discussed. (auth)

20242 SOME QUESTIONS PERTAINING TO THE METHODS USED IN THE STUDY OF THE EFFECTS PRODUCED BY ANTIRADIATION AGENTS. Bychkovskaya, I. B. Med. Radiol., 12: No. 3, 69-77(Mar. 1967). (In Russian).

Questions pertaining to methods used in the study of the effects produced by radioprotective compounds are proposed and discussed. It was noted that a regularity in response to radiation treatment occurred in a wide range of biological systems. Emphasis was placed on the fact that this circumstance should be considered when effects on survival and average life span of biological systems are produced by radioprotective compounds. It was pointed out that this makes it possible to judge the mode of action exerted by the agent and helps to prevent errors in evaluation of their effectiveness. An analysis of data on the influence exercised by hypoxia, AET, and mexamine on irradiated mice was presented in this manner. It was advised that in order to assess the efficiency of radioprotective compounds in diverse types of radioinduced death, the dose reduction factor within a broad range of radiation dosage rates should be calculated. (auth)

20243 ENHANCED RESISTANCE TO ULTRAVIOLET IRRADIATION IN BACTERIAL POPULATIONS EXPOSED TO PERIODATE. Ryan, Ann M. (Columbia Univ., New York). Biochim. Biophys. Acta, 134: 197-9(Jan. 25, 1967).

Cells of different strains of Escherichia coli were exposed to sodium metaperiodate, then uv irradiated. Survival criterion was the capability to form colonies on nutrient agar plates. Most strains had enhanced resistance to the lethal action of uv regardless of mating type, but two which act as females in matings respond to a smaller degree. In some cultures, high concentrations of periodate which produced no further increment in survival inactivated phage production at the same rate. That these results are not caused by a general oxidative effect is shown by the failure of hydrogen peroxide to decrease radiosensitivity. It is suggested that some cell wall constituent may be the uv irradiation target whose prior destruction by periodate enhances the radiation survival of the population. This presumptive target may be male-specific since all the donor strains tested which exhibited marked decrease in radiosensitivity were derived from an original F^+ isolate. (C.O.)

20244 RADIOSENSITIVITY OF NEOPLASTIC THYMOMA. Mushina, L. N. Med. Radiol., 12: No. 2, 18-20(Feb. 1967). (In Russian).

The paper describes one observation concerning a 53-year-old patient in whom roentgenologically the author revealed a mediastinal tumor which proved to be a neoplastic thymoma. The diagnosis was established during exploratory thoracotomy with biopsy. After a course of radiotherapy carried out six months after the operation the tumor significantly decreased in size, the state of the patient is satisfactory, although four years later roentgenologically there was noted again a certain enlargement of the tumor. The interest of this observation consists in the fact that notwithstanding popular opinion, x-ray therapy proved to be quite effective in cancer of the thymoma. (auth)

20245 ASSESSMENT OF SCANNOGRAMS OF THE LIVER OBTAINED WITH THE AID OF RADIOIODINE-LABELED ROSE BENGAL AND COLLOIDAL RADIOGOLD IN ONCOLOGICAL PATIENTS. Degtyarenko, V. V.; Agranat, V. Z. Med. Radiol., 12: No. 2, 20-6(Feb. 1967). (In Russian).

On the basis of analysis of the material gathered during the examination of 230 patients with malignant neoplasms of diverse localization (liver, stomach, intestine, lungs, female reproductive organs, mammary gland, retroperitoneal space, etc.) by the method of scanning the authors give an assessment of scannograms of the liver obtained with the aid of radioiodine-labelled rose bengal and colloidal radiogold. The authors enumerate the relative indications to the use of each preparation for radioisotope scanning of the liver. (auth)

20246 OPTICAL TRANSFER FUNCTION OF RADIOISOTOPE SCANNING. I. Takenaka, Eiichi (Tokyo Univ.); Kinoshita, Kojiro; Nakajima, Rokuhiko. Radioisotopes (Tokyo), 16: 73-7 (Feb. 1967). (In Japanese).

Fourier analysis has not yet been applied to the analysis of radioisotope image transmission systems. Using ^{131}I-paper Siemens star, the optical transfer function (OTF) of the system was measured, and theoretical calculations were confirmed. Various types of collimators were examined quantitatively, and the effective lengths were obtained in the case of focusing and defocusing. When tissue absorption was accounted for in calculations, the average cut-off frequencies (OTF-0) through tissue thickness corresponded to the clinical perceptible limits of hole defect size. Thus, it is concluded that the treatment of OTF is very useful for the quantitative diagnosis of radioisotope image, as well as comprehension and improvement of radioisotope image transmission system. (auth)

20247 SYNERGISTIC EFFECT OF LASER RADIATION AND IONIZING RADIATION ON MALIGNANT TUMORS IN VIVO AND IN VITRO. Helsper, James T.; Sharp, George S.; Rounds, Donald E. (Pasadena Tumor Inst., Calif. Pasadena Foundation for Medical Research, Calif.). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 99: 446-9(Feb. 1967).

The nature of this preliminary study did not permit quantitation of the combined x-ray and laser therapy in vivo. However, the response of the lesions was consistent with the observed synergism

in an earlier in vitro study. The data from this study also appear to confirm previous reports that laser energy alone has some tumoricidal effect. However, we have recently observed that even a 100 joule focused ruby laser beam will not destroy muscle or kidney tissue beyond a depth of a few millimeters. This severe limitation is the result of several physical conditions, including the fact that scattering within the tissue prevents the accumulation of the required photon density for cellular disruption. It was further observed that a portion of the photons from a 20 joule unfocused ruby laser beam could be detected at a tissue depth of 5 cm., which can be considered important in the potentiation of x-rays at these depths. The range of wavelengths which show optimal penetration of human tissue is from 10,000 to 12,000 Å. This suggests that a neodymium pulsed laser (10,600 Å) or a modified He–Ne continuous wave laser (11,500 Å) may have more value than the ruby laser for this purpose. Moreover, it has been reported that x-ray induced aberrations in Tradescantia microspores could be increased with wavelengths as long as 11,500 Å. The comparative value of infrared laser sources for the potentiation of x-ray is currently being investigated. (auth)

20248 POSSIBILITIES FOR THE APPLICATION OF FAST NEUTRONS IN RADIOTHERAPY: RECOVERY AND OXYGEN ENHANCEMENT OF RADIATION INDUCED DAMAGE IN RELATION TO LINEAR ENERGY TRANSFER. Barendsen, G. W. (Radiobiological Inst. TNO, Rijswijk, Netherlands). Europe. J. Cancer, 2: 333-45(Dec. 1966).

Experimental data concerning recovery of radiation-induced damage in mammalian cells show that this phenomenon is much less important after fast neutron irradiation than after x- or γ-irradiation. This difference is related to differences between the shapes of survival curves obtained with high LET and low LET radiations respectively and influences the effects of fractionation. The enhancement by oxygen of radiation damage, which can be quantitatively expressed by an oxygen enhancement ratio (OER), is equal to about a factor of 1.6 for fast neutrons and about a factor of 2.6 for x rays. As a consequence of these two differences between effects of fast neutrons and of x- or γ-rays, important variations between different tissues may be found with regard to the relative biological effectiveness (RBE) of fast neutrons as compared with x-rays. For the irradiation of anoxic cells, which may be found in many tumors, it can be shown that the RBE of fast neutrons may be expected to be higher than for well oxygenated cells present in normal tissues. This expectation is the basis of a renewed interest in the application of fast neutrons for the radiotherapy of tumors. In addition, differences in recovery may be important. A discussion is given of the neutron energy which is most suitable for this purpose and it is concluded that with respect to good depth dose characteristics as well as with regard to low OER values, 15 MeV neutrons seem to offer the best prospects. (auth)

20249 CHANGES OF MORPHOLOGICAL STRUCTURE OF THE MAMMARY GLAND CANCER INFLUENCED BY RADIOTHERAPY. Neishtadt, E. L. (Inst. of Oncology, Leningrad). Vop. Onkol., 12: No. 12, 14-19(1966). (In Russian).

Preoperative radiotherapy injuring the primary tumor node cells does not destroy them completely, as it has been found in 300 specimens of the mammary gland cancer in women, 150 of them being subjected to preoperative roentgenotherapy. At the same time, application of massive doses of the x rays results in deep damage both of the tumor and the gland stroma. Probable inhibition of the immunobiological reactions by the large doses of the x rays is supposed to be favorable for the tumor growth recurrence and metastasizing. (auth)

20250 ULTRASTRUCTURAL MODIFICATION AFTER RADIOPROTECTORS. Hugon, J.; Maisin, J. R.; Borgers, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Int. J. Radiat. Biol., 11: 105-16(1966). (In French).

The ultrastructural study on stem cells of the duodenal crypt in mouse injected with AET, glutathione, serotonin, separately or in combination, shows that the subcellular organites modified by these drugs are the mitochondria, the ergastoplasm, and the lysosomes. The ergastoplasmic reaction does not seem specific; it may be that the mitochondrial changes are the morphological aspect of enzymatic lesions of the cristae. The increasing number and the swelling of the lysosomes, 3 hours after the injection, suggest that the protectors are perhaps withdrawn by this method. (auth)

20251 RAPID DIAGNOSIS OF STEATORRHEA BY EXTERNAL COUNTING OF ABDOMEN AFTER ^{131}I-LABELED FAT ADMINISTRATION. Hershenson, Lee M. (Univ. of Pittsburgh). J. Nucl. Med., 7: 896-908(Dec. 1966).

External measurement of radioactivity remaining in the abdomen eight hours after oral administration of ^{131}I-triolein or ^{131}I-oleic acid offers a rapid method for detecting abnormal fat absorption. With counter collimation and geometry as described in this study, eight-hour external abdomen radioactivity counts in 21 subjects with normal digestion and absorption averaged 23.3 per cent of the administered dose (standard deviation 6.6 per cent). In 21 patients with various abnormalities of gastrointestinal function, the results of the external abdomen absorption measurements were correlated with the clinical status and with fecal radioactivity measurement of ^{131}I labeled fat absorption. The experiences of this study indicate that this method can detect abnormal fat absorption rapidly. Because the test can be completed in one day, the need for cooperation by the patient is minimized. A normal dietary intake is not required, and stool specimens are saved only during the eight-hour test period. Patients with gastric retention or marked urinary retention are not suitable for this test, however. (auth)

20252 EFFECT OF 3-METHYLCHOLANTHRENE AND X IRRADIATION, GIVEN SINGLY OR COMBINED, ON RAT MAMMARY CARCINOGENESIS. Shellabarger, Claire J. (Univ. of Michigan, Ann Arbor). J. Nat. Cancer Inst., 38: 73-7(Jan. 1967).

Female Sprague-Dawley rats were given a single, intragastric administration of 40 mg of 3-methylcholanthrene on the 40th day of age, or 400 R of total-body x radiation on the 50th day, or both, or the sequence of administration of the two carcinogenic agents was reversed. The percentage of rats with one or more mammary adenocarcinomas and the total number of mammary adenocarcinomas were obtained when the animals were killed at 140 days of age. The results were interpreted to mean that the effects of x radiation and 3-methylcholanthrene were additive. (auth)

20253 NERVOUS COMPONENT IN THE MECHANISM OF PROTECTIVE ACTION AGAINST ANTI-RADIATION AGENTS. Strelkov, R. B.; Kosichenko, L. P. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Byull. Eksp. Biol. Med., 63: No. 2, 101-4(Feb. 1967). (In Russian).

The authors studied the local (instillation into the conjunctival sac) and general (subcutaneous injection) action of mexamine and betamercaptoethylamine on processes of cellular growth of the epithelium of the conjuctiva of white mice after total gamma-irradiation in a dose of 100 R. Local application of BMEA exerted a protective anti-radiation effect, while mexamine (5-methoxytryptamine) in the same conditions was ineffective. Parenteral administration of mexamine protected the conjunctival epithelium from ionized radiation; under the same conditions BMEA gave no protection. It was concluded that the mechanism of action of aminothiols and indolylalkylamines is different: protective mechanism of indolylalkylamines has a specific nervous component, which takes part in the realization of anti-radiation properties of the agent. (auth)

20254 INFLUENCE OF INTESTINAL CONTENT ON RADIATION LESIONS OF THE SMALL INTESTINE. Hiatt, Nathan; Warner, Nancy E. (Cedars-Sinai Medical Center, Los Angeles). Proc. Soc. Exp. Biol. Med., 124: 937-9(Mar. 1967).

The abdomens of dogs with Thiry-Vella fistulas of the jejunum were irradiated with 1,000 and 1,500 R. The post-irradiation lesions in the small intestine in continuity were typical. Those in the fistulas, where intestinal content was absent, were considerably less intense. (auth)

20255 EFFECTIVENESS OF HYALURONIC ACID COMBINED WITH OTHER THERAPEUTIC PREPARATIONS IN EXPERIMENTAL RADIATION BACTEREMIA. Ter-Avetisyan, A. T. Biol. Zh. Arm., 19: No. 11, 46-51(Nov. 1966). (In Russian).

The combined effects of hyaluronic acid and therapeutic drugs on the dynamics of bacteremia in white mice weighing 18 to 20 g and x-irradiated with 600 R were studied. Intraperitoneal and peroral administration of hyaluronic acid with adrenalin, biomycin, and vicasol drugs diminished the bacteremia and brought about a higher percentage of survival. The treatment was not effective during the first 5 days of bacteremia. (R.V.J.)

20256 SUBMICROSCOPIC CHANGES IN MARROW CELLS DURING RADIATION SICKNESS CAUSED BY RADIOACTIVE STRONTIUM. Khomutovskii, O. A. (Inst. of Physiology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 13: 79-89(Jan.-Feb. 1967). (In Ukrainian).

After administration of radioactive strontium (^{90}Sr in doses of 0.32 μCi/g) to rats, changes occur in the submicroscopic structures of the marrow cells. The intensity of these changes depends on the quantity of absorbed energy and the stage of maturity of the cellular forms. The susceptibility to radiation of the ultrastructures of the cells of the leukoblastic and erythroblastic series are about the same, chronic irradiation of the marrow (25-30 rads/day) disturbs the processes of regeneration, as a result of which there occurs formation of atypical submicroscopic structures. Restoration of marrow cell function does not, apparently, take place after even a long time. (auth)

20257 CHANGE IN THE CHOLINESTERASE ACTIVITY UNDER THE EFFECT OF SMALL DOSES OF RADIOACTIVE IODINE. Milko, V.; Surkov, G. (Medical Inst., Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 13: 90-4(Jan.-Feb. 1967). (In Ukrainian).

The change in the cholinesterase activity in the rat as well as in the blood and serum of syringomyelia patients, under the effect of small quantities of radioactive iodine (^{131}I) was determined. A rise in acetylcholinesterase activity and a fall in benzoylcholinesterase activity were noted, which may be due to the beneficial therapeutic effect of radioactive iodine during syringomyelia. (auth)

20258 QUICK METHOD OF CONSTRUCTING ISODOSE CURVES IN THE HUMAN BODY. Boev, K.; Mitrani, L.; Ganchev, M. (Inst. of Physiology, Sofia. National Research Inst. of Oncology, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 1131-3(1966).

A method of constructing isodose curves for determining dose distribution from the blackening of a photoplate is described. This method involves less time and work than other methods. A television system of the alpha type is used. Videosignals from the camera are amplified with two independent amplifiers. The amplified videosignals are fitted to the input of the discriminating system. The level of discrimination is in direct relation to an equidensic curve according to the isodose curve. Therefore, the contour of the area that appears on the screen is, in fact, the isodose curve. By changing the discrimination level it is possible to draw the isodose curves easily and gradually. (H.L.W.)

20259 COLLIMATOR SYSTEM FOR SCANNING AT LOW ENERGIES. Richards, P.; Atkins, Harold L. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. J. Nucl. Med., 8: 143-53(Feb. 1967). (BNL-10393).

A special thin septa collimator was designed for use with ^{99m}Tc and other low-energy gamma-emitting isotopes in scanning. The basic 1''-thick collimator, designed for use with a 3'' detector, has 1045 holes, a 0.015'' septa thickness, a 3.5'' focal length, and a 50% response diameter of ~0.23''. Variations of the basic collimator are made by making the unit thinner or thicker. Thinner collimators give an increased field of view resulting in higher counting rates, while increased thickness gives higher resolution with decreased sensitivity. Provisions were also included for mounting masking rings or discs on the face of the collimator for use in altering the angle intercepted by the detector and thereby changing the depth response of the system. A simple rapid technique has been developed for vacuum casting the collimator by melting lead around pins mounted in a base plate. Base plate and pins may be reused many times for additional castings. (auth)

20260 MEASUREMENT OF EFFECTIVE RENAL PLASMA FLOW IN MAN BY EXTERNAL COUNTING METHODS. Blaufox, M. Donald (Harvard Univ., Boston. Peter Bent Brigham Hospital, Boston); Potchen, E. James; Merrill, John P. J. Nucl. Med., 8: 77-85(Feb. 1967).

A method was devised to measure accurately the effective renal plasma flow (ERPF) in man by external counting over the head after a single injection of Orthoiodohippurate-^{131}I. The external head curve is calibrated with two plasma samples drawn at three or five minutes and sixty minutes. The clearance is calculated from the slopes and intercepts of the components of the corrected curve as plotted on semilogarithmic graph paper. This method correlates closely with clearance calculated from continuous infusions of PAH ($r = 0.89$). The previously reported correlation of plasma OIH clearances and PAH clearance is confirmed. External counting offers a means of determining renal function accurately without urine collection or multiple venepunctures. (auth)

20261 A SENSITIVE TECHNIQUE FOR MEASURING THYROIDAL UPTAKE OF ^{131}I. Wellman, Henry N. (Public Health Service, Cincinnati); Kereiakes, James G.; Yeager, Thomas B.; Karches, Gerald J.; Saenger, Eugene L. J. Nucl. Med., 8: 86-96(Feb. 1967).

A unique, sensitive dual crystal system for thyroidal iodine uptake and kinetics utilizing photopeak to Compton scatter characteristics is described. The results obtained with the system were shown to correlate highly with those obtained with a standard-thyroidal uptake system. The minimum detectable level for the dual crystal system placed inside the whole body counting room is 100 pCi (five-minute counting time for a 2.75 centimeter effective thyroid depth at the 95% C.L.). Because of the sensitivity of the system described, it offers a wide range of capabilities. One can markedly reduce the dose necessary for thyroidal uptakes, especially in children. Small quantities of radioiodine that might be present in the thyroid from environmental contamination can be quantitated. Radioiodine kinetics can be studied for extended periods of time with much smaller doses than used for the usual radioiodine uptake. (auth)

20262 SYNGENEIC MARROW GRAFT: EFFECT ON PERSISTENCE OF PREIRRADIATION IMMUNITY TO HYMENOLEPIS NANA IN MICE. Friedberg, Wallace; Neas, Barbara R.; Friedberg, Mary H.; Faulkner, Donald N. (Federal Aviation Agency, Oklahoma City). Proc. Soc. Exp. Biol. Med., 124: 792-3(Mar. 1967).

X-irradiated mice preimmunized to Hymenolepis nana were injected with either 1 million or 40 million syngeneic bone-marrow cells from nonimmune mice or with 204 million rat marrow cells. Twenty-two days after irradiation the mice were given H. nana eggs. Infection rates were lowest in the animals injected with the larger number of syngeneic marrow cells; the mice implanted with rat marrow had the highest infection rates. It was concluded that transplanted syngeneic marrow from nonimmune donors makes less severe (or prevents) a radiation-induced depression of acquired immunity. (auth)

20263 INCREASED RADIORESISTANCE OF CCl_4-DAMAGED MICE. Tribukait, Bernhard; Lindberg, Kaj (Karolinska Institutet, Stockholm). Naturwissenschaften, 54: 92-3(Feb. 1967). (In German).

Male mice were injected with 0.5 mg CCl_4/g of body weight at various times before irradiation with ^{60}Co at doses between 950 and 1150 R. The radiation sensitivity of the CCl_4-poisoned mice was significantly reduced. At irradiation doses of 1050 and 1150 R all the CCl_4-poisoned animals died, but the death was delayed with respect to the control animals. The survival rate with irradiation 48 and 72 hrs after the CCl_4 injection was approximately equal; 96 hrs after the injection the radiosensitivity began to be normalized. The mechanism explaining this increased radiation resistance is unclear. (J.S.R.)

20264 THE VALUE OF ^{85}Sr BONE SCANNING IN RADIATION THERAPY. Sklaroff, David M.; Charkes, N. David (Albert Einstein Medical Center, Philadelphia). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 99: 415-21(Feb. 1967).

Metastasis to bone is a frequent source of pain in patients with cancer, and the response to radiation therapy is often very gratifying. This is especially true if the primary site is the breast, where rapid, complete relief can be obtained in at least 80 per cent of the patients. To obtain maximum benefit, the radiation therapy must be delivered to the exact site which is producing the symptoms. Scanning with strontium 85 has been extremely helpful in obtaining this information. Our experience indicates the usefulness of scanning the skeletal system with strontium 85 in patients suspected of having metastatic bone disease in the following situations: To check the adequacy of treatment portals. To determine whether the disease is localized or generalized in order that appropriate systemic therapy can be given if needed. To locate areas requiring therapy. To locate a suitable site for bone biopsy in order that a histologic diagnosis can be established. (auth)

20265 COMPUTER TECHNIQUE FOR INVESTIGATING THE RATIONALIZATION OF SCINTILLATION SCAN READING. Evans, M. R.; Sweeney, J. W. (Tulane Univ., New Orleans). Meth. Inform. Med., 6: 24-7(Jan. 1967).

Automated analysis of a thyroid scintillation scan is considered, and a computer program described for interpretation of such scans. Each lobe is contoured at levels derived from the standard deviation (σ) of the count rate within the lobe; for each area of increased or decreased isotope uptake, its size, location, and statistical description are given. Each lobe of the thyroid is contoured at intervals measured from the lobar mean, the interval being some fraction of the lobar deviation. This fraction is one of the free parameters; however, 0.2 σ and 11 levels on each side of the mean (the 11th slice on either side serving for all values >2.0 σ) works well. Every site outside the thyroid is labeled 11; positive and negative numbers are levels above and below the mean; and 0 indicates a value within 0.2 σ of the mean on either side. A dead zone is constructed around the mean; the number of intervals it includes on the hot and on the cold sides are given independently. All image elements falling within this zone are set to zero. When the resultant matrix is plotted, using letters for high count rates and numbers for low count rates, an evaluation can be made of its resemblance to the original image, as processed, rather than as seen, by the radiologist. Some quasi-independent program parameters have been left free for experimental variation in attempts to determine the settings which best approximate the radiologist's eye. (BBB)

20266 POST-IRRADIATION CHANGES IN THE LUNGS AFTER RADIOTHERAPY OF THE BREAST CANCER. Kukolewska-Machnicka, Jadwiga. Pol. Przegl. Radiol. Med. Nuklearnej, 31: 141-7(Jan.-Feb. 1967). (In Polish).

Post-irradiation changes in the lungs, observed in the course of radiotherapy of carcinoma of the breast, are described. In 72

observed patients 19 post-irradiation changes were observed (26.4%). The post-irradiation changes were most frequent in patients treated after surgery when roentgentherapy was applied using 5 fields and tangential irradiation of the scar. (auth)

20267 THE VALUE OF RADIOTHERAPY IN THE TREATMENT OF CEREBRUM AND CEREBELLUM HEMANGIOBLASTOMA. Hartel-Ulkowska, Narcyza; Ulkowski, Miroslaw. Pol. Przegl. Radiol. Med. Nuklearnej, 31: 155-60(Jan.-Feb. 1967). (In Polish).

The results of postoperative irradiation treatment, applied in 14 cases of cerebrum and cerebellum hemangioblastoma, are presented. In these cases, 5 subtotal operations were performed and in 2 cases only craniotomy and decompression was done. Basing on references data and on personal experience, the authors conclude, that post-operative irradiation is well founded in cases of subtotal surgical procedures and leads to a prolongation of the survival rate and an amelioration of the neurological state of these patients. Holding in view the to-date high post-operative mortality rate and technical surgical difficulties in the performation of total operation, the radiotherapy remains as a valuable therapeutic measure in these cases. (auth)

20268 PREVENTION OF DEATH IN RATS FROM RADIATION SICKNESS BY SCREENING A PART OF BONE MARROW DURING IRRADIATION. Gronskaya, N. F. (Central Roentgen-Radiological Inst., Leningrad). Byull. Eksp. Biol. Med., 63: 27-30(Jan. 1967). (In Russian).

Wistar male rats were irradiated with x rays in doses of 800, 720, and 650 R. The relation between the protective effect of the volume of screened bone marrow and the dose of radiation was studied. It was found that the protective effect of screening of bone marrow depends on the volume of bone marrow screened, as well as the dose rate. The smaller the dose and the greater the screened area of bone marrow the greater the percentage of survival of animals after irradiation. With sublethal doses of irradiation, when part of the rats survive and death during the period of "intestinal death" is small, screening of a definite part of bone marrow during irradiation gives 100% survival rate. Further increase of screened volume of bone marrow gives no further effect. In total irradiation with lethal doses the survival rate is limited due to death of rats from the "intestinal syndrome," which is not prevented by screening of the bone marrow. Increase of the screened area of bone marrow is effective up to a certain volume screened, which rises with the increase of the radiation dose. (auth)

20269 PROTECTION FROM RADIATION LETHALITY BY ALLOXAN. Doolittle, Donald P.; Watson, Joseph A. (Univ. of Pittsburgh). Int. J. Radiat. Biol., 11: 389-91(1966).

Male mice were whole-body x irradiated at doses of 550 or 850 R. Injections of alloxan, a chemical diabetogenic, given within a few hours reduced the level of radiation mortality below that of mice injected with saline solution. It is suggested that the effects of alloxan may be mediated through calcium metabolism. (C.O.)

20270 DISTRIBUTION OF ^{95}Nb LABELLED PLASMA AND FIBRINOGEN IN TUMOUR BEARING RATS. Misra, U. K. (Hammer Smith Hospital, London). Indian J. Exp. Biol., 4: 193-5 (Oct. 1966).

This distribution of ^{95}Nb labelled plasma and fibrinogen, 4 hr after administration of single intravenous injection, has been studied in the tissues of tumor (RIB 5, a fibrosarcoma) bearing male rats (Wistar strain). Highest concentration of ^{95}Nb is observed in labelled plasma injected rats in spleen (5.86 per cent/g.) followed by liver, plasma, kidney, tumor and heart. In labelled fibrinogen injected rats the concentration of ^{95}Nb is almost equal in liver and spleen followed by plasma, kidney, tumor and heart. In liver subcellular fractions the microsomal fraction shows the highest concentration of ^{95}Nb whereas in tumors the highest concentration of ^{95}Nb is present in the supernatant fraction. (auth)

20271 COMPLETE REMISSION IN CHRONIC LYMPHOCYTIC LEUKEMIA AND LEUKOLYMPHOSARCOMA. Han, Tin (Roswell Park Memorial Inst., Buffalo); Ezdinli, Ediz Z.; Sokal, Joseph E. Cancer, 20: 243-53(Feb. 1967).

Seven instances of complete remission, confirmed by bone marrow aspiration, were observed among 202 patients with chronic lymphocytic leukemia and leukolymphosarcoma treated during a 10-year period. Review of these cases and of 10 instances reported by others revealed that complete remission of disseminated lymphoproliferative disease was observed more frequently after x-ray irradiation than after other modalities of treatment and that many remissions followed treatment which might be considered inadequate. The authors conclude that host factors must have played a major role in these cases but that in almost all of them improvement was clearly related to the administration of specific therapy. A characteristic pattern of response was associated with each therapeutic modality and x-ray irradiation produced the most rapid correction of circulating lymphocytosis. (auth)

20272 MODIFICATION OF RADIOSENSITIVITY. Foye, Laurance V. Jr. (Univ. of California, San Francisco). Cancer Progr., 203-20(1963).

This review of 279 reports considers the effects of various chemical agents, including oxygen, on the enhancement of injury to tumor cells by ionizing radiations. Results with the following compounds are described: actinomycin D, various alkylating agents, Synkavit, halogenated pyrimidine analogs, and L-triiodothyronine. Use of various radioprotective agents is also considered, as are the effects of hypoxia and hypothermia. This survey showed that in spite of the overwhelming evidence that radiosensitivity of tumor cells, or of all cells, was significantly modified by the administration of various physical and chemical agents, there has been little tendency towards their use in routine clinical radiotherapy. Factors contributing to this situation were listed as (1) the realization that data from cell culture and experimental rodent tumor studies are not necessarily applicable to human disease; (2) the cumbersome, and in some cases, dangerous methods required to administer some of the described sensitizing agents; (3) the failure of many of the reported studies to demonstrate a differential modification of the sensitivity of tumor cells and normal cells without which improvement in therapeutic results can not be expected; (4) and most important, the paucity of controlled studies of these agents in humans demonstrating an improvement in therapeutic results. (BBB)

20273 REDUCTION IN RADIATION LETHALITY BY MIXTURES OF CHEMICAL PROTECTORS. Maisin, J. R.; Mattelin, G. (Centre d'Etudes de l'Energie Nucleaire, Mol, Belg.). Nature, 214: 207-8(Apr. 8, 1967).

Studies are reported on short and long term survival of mice treated with mixtures of chemical protectors before exposure to x radiation. The conditions of irradiation were 300 kV, 20 ma, 2 mm copper, dose rate in air 100 to 175 R/min. After treatment with a mixture of AET(2-β-aminoethylisothiourea), glutathione, and serotonin the $LD_{50/30}$ and the $LD_{99/30}$ days increased to 1,350 and 1,850 R, respectively (dose reduction factors 2 and 2.2). When cysteine was added to the mixture $LD_{99/30}$ rose to 2,250 R (dose reduction factor 3). Administration of nucleated bone marrow cells after x-ray exposure to mice treated with AET, glutathione, and serotonin increased $LD_{50/30}$ and $LD_{99/30}$ to 1,650 and 2,050 R, respectively (dose reduction factors 2.5 and 2.7), and in the presence of cysteine to 2,200 and 2,400 R (dose reduction factors 3.2 and 3.3). A long term survival study of mice treated with a mixture of AET, glutathione, and serotonin, and irradiated at 1,500 to 2,200 R, indicated that most died within 6 months. Addition of cysteine, with or without bone marrow cells, produced no improvement. Addition of glutathione and cysteine to a mixture of AET and serotonin decreased toxicity. Results show that mixtures of radioprotective compounds are able not only to increase the protection offered by each compound separately, but also to decrease the toxicity of compounds such as AET. Suggestions as to mechanisms are made. (UK)

20274 MODIFICATION OF THE ACUTE LETHALITY IN MICE FOLLOWING WHOLE BODY X-IRRADIATION BY SEVERAL VASOCONSTRICTING AGENTS. Nakatsuka, Haruo; Shakudo, Yozo (Osaka City Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 437-45(Aug. 1966).

Experimental studies were made on the protective effect of several vasoconstricting agents for mice exposed to lethal whole body x irradiation with the following results: Markedly effective were phenylephrine, naphazoline, tetrahydrozoline and norepinephrine. Considerably effective were cocain and epinephrine. Slightly effective were caffeine and phenylethylamine. Non-effective was ephedrine. The radio-protective effect of these vasoconstricting agents was the highest at an optimal dosage, higher level or lower level of which revealed proportionally less effect. Phenylephrine was most effective when administered intraperitoneally 5-10 minutes before exposure to x rays. It showed a marked decrease in efficacy against x radiation 30 minutes after administration, losing its effect 60 minutes after administration. No radio-protective effect was observed when the agent was administered immediately after irradiation. As a possible mechanism of the radioprotective effect of these vasoconstricting agents, the tissue hypoxia due to vasoconstriction is discussed. (NSA of Japan)

20275 EFFECT OF PREOPERATIVE ROENTGEN THERAPY UPON THE TENSILE STRENGTH OF RECTOSIGMOID ANASTOMOSES IN DOGS. Heupel, H. W.; Veinbergs, A.; Humphrey, E. W. (Veterans Administration Hospital, Minneapolis). Radiol. Clin. Biol., 35: 129-40(1966).

Thirty-six dogs received a tissue dose of 1500 R to the lower

colon. A rectosigmoid anastomosis was performed after various intervals of time and the animals were sacrificed at period of 1 week, 10 days, and 17 days after surgery. The tensile strength of the anastomoses was tested by inflation of the excised specimens. A control group of 27 dogs with rectosigmoid anastomoses received no preoperative irradiation. They were also sacrificed after various postoperative intervals and the tensile strength of the anastomoses was tested in the same manner. The values obtained in the irradiation group and in the control group were significantly similar. During the first 10 postoperative days the tensile of the adjacent colon exceeded that of the anastomosis in both groups. After 2 weeks the adjacent distended colon ruptured before rupture of the anastomosis could occur. There was no correlation between the irradiation to operation intervals and the tensile strength of the anastomoses. Histological evidence of x-ray injury was found in preoperatively irradiated animals and in an x-ray control group of 13 dogs. It is concluded that, under the experimental conditions described, there is no measurable effect of preoperative irradiation upon the tensile strength of rectosigmoid anastomoses. (auth)

20276 RADIATION THERAPY OF SALIVARY GLAND TUMORS. Evans, J. C. (Yeshiva Univ., New York). Radiol. Clin. Biol., 35: 153-91(1966).

Conclusions from the use of single large-dose radiations instead of split dose techniques are given. For benign mixed tumor, the proper treatment is radical surgery. If limited surgery is done for any reason, or multiple operations are required, post-operative irradiation will decrease or delay the incidence of recurrence, with little likelihood of complication. Malignant mixed tumor is rarely radiosensitive to a useful degree. Although half showed some response to modest doses of irradiation, this did not aid in salvage. Among other malignant tumors, the muco-epidermoid and pure squamous carcinomas are the only group in which radiotherapy plays a major role. Nearly all show a considerable radiation response. Although no cure was achieved by radiation therapy alone in this series, such has been reported by others with more radical radiation dosage. Post-operative irradiation also seems highly beneficial in preventing local recurrence. Cylindromas, although responding temporarily to low doses of radiation, are rarely cured unless resectable. For large tumors, preoperative irradiation and radical parotidectomy seems the only possible mode of cure. The other adenocarcinomas rarely show a significant radiosensitivity, but the rare exception makes treatment mandatory if the tumor is inoperable. There does not appear to be any histologic guide to selecting the rare adenocarcinoma that is radiosensitive. Among other benign tumors, the oncocytoma and benign lymphoepithelial lesion may be quite radiosensitive, if excision is contraindicated. Radiation therapy cannot be ignored in the proper management of salivary gland tumors. (C.O.)

20277 PROBLEMS, METHODS, AND RESULTS OF THE SINGLE SHOT ^{57}Co CYANOCOBALAMIN-CLEARANCE. Haas, Jean Peter; Prellwitz, Winfried (Johannes-Gutenberg-Univ., Mainz). Strahlentherapie, 131: 612-22(Dec. 1966). (In German).

Due to its most favorable properties, which no known substance exhibits, ^{57}Co-cyanocobalamine is presently considered to be the best substance for the determination of the glomerular filtration rate. Our own experimental investigations with the Gel-filtration-technique could clarify questions previously unsolved in the protein binding of Vitamin B_{12}. The new single-shot method, which was improved during our clinical applications, shows advantages when compared with investigations done during the steady state; this method simplifies considerably the clearance procedure and minimizes the burden and danger for the patient. As was shown in comparative studies with the classical inulin-clearance, the values obtained are statistically reliable and reproducible. (auth)

20278 PROGNOSTIC SYMPTOMS AND SIGNS IN HODGKINS DISEASE AND THEIR SIGNIFICANCE FOR RADIOTHERAPY. Musshoff, Karl; Boutis, Lazaros; Laszlo, Arthur Martin; Laszlo, Ingrid (Univ., Freiburg i. B.). Strahlentherapie, 131: 482-504 (Dec. 1966). (In German).

Of 289 cases which were primarily diagnosed and treated in Freiburg, 184 have died. The 5-year cure rate is 40.6%. There are two types of this disease: a severe type with a maximum survival time of 4 years, and a lighter type with survival times of more than 4 years. Differentation of the two types can be made using prognostic signs and symptoms. It is concluded that the prognostically more favorable types of the lymphogranulomatosis should be treated with high energy radiation only and not with cytostatic substances and that in order to obtain a long lasting first remission, the initial treatment must be done immediately after securing the diagnosis, using the most effective measures: irradiation of all diseased lymph nodes with focal doses of 4000 R and prophylactic inclusion of adjacent healthy lymph nodes. (C.O.)

20279 EFFECTS OF DRINKING SPRING WATERS ON IRRADIATION INJURY. Yamada, Tomiko (Kyushu Univ., Fukuoka). Onken Kiyo, 18: No. 1, 50-5(Mar. 1966). (In Japanese).

Rabbits were irradiated with doses of 500 R and then given spring water to drink for 2 weeks. The water was from Onken, Yu-no- Hana, and Genbaku. The effect of the spring water was to inhibit radioinduced cell depletion in bone marrow and to increase hematopoiesis. It was concluded that spring water may accelerate recovery from radioinduced depression of bone marrow. It was postulated that the effect of the spring water was due to thiols and rare substances in the water. (H.L.W.)

20280 OXYGEN TENSION AND THE RADIOSENSITIVITY OF TUMORS. Gray, L. H.; Scott, O. C. A. (Mt. Vernon Hospital, Northwood, Eng.). pp 537-48 of Symposium on Oxygen in the Animal Organisms. Dickens, F.; Neil, E. (eds.). London, Pergamon Press, 1964.

Experimental data and theories relating to the radiosensitizing action of oxygen on tumors are reviewed. Some possible mechanisms involved in the physicochemical role of oxygen are considered. A discussion of the importance of oxygen in radiotherapy revealed that the large physico-chemical effect of oxygen, amounting to a factor of 2-3 in sensitivity, may profoundly affect tumor cell survival. Although the shape of survival curves of cells irradiated in oxygen and nitrogen appears to be different, it is generally found that oxygen acts as a dose modifying factor, i.e., it does not affect the shape of the dose response curve but (at sufficient concentration) renders a dose $D/_m$ delivered in the presence of oxygen as effective as a dose D delivered in its absence. The parameter m is referred to as the oxygen/nitrogen ratio. By modifying the conditions under which bacteria are cultured after irradiation, the value of m may be changed from 1.6 to 3.7. For most cells irradiated under normal physiological conditions, m is found to be between 2 and 3, and for mammalian cells is generally ~2.5. Survival of some tumor cells in anoxic foci has been shown to be responsible for the failure of radiotherapy to eradicate some forms of tumor, such as lymphosarcoma. An appreciable percentage of the cells of the solid growing tumor, while still retaining the capacity to regenerate the tumor, were, at one time, virtually anoxic. This confirmed a mass of indirect evidence and it would be of great importance to the radiotherapist to know whether human tumors similarly contain a small proportion of anoxic cells. Taking into account the observed relation between the proportion of survivors and the dose, at the level of dose used in treating human tumors, an oxygen/nitrogen factor of 2.5 could easily make all the difference between curability and incurability of a tumor. (BBB)

20281 COMPUTER PROGRAM FOR DOSE PLANNING WITH ANALYTICAL REPRESENTATION OF RADIATION FIELDS. Kalnaes, Ole (Municipal Hospital of Aarhus, Denmark). Acta Radiol., Therapy, Phys., Biol., 4: 449-58(Dec. 1966).

The theory and practical use of a computer program for automatic calculation of isodose curves in cobalt 60 radiation therapy are described. The program is based on an analytical representation of radiation fields including those from wedge filters, correction being made for patient contour and air-filled tissue. The result is given directly from the computer as complete isodose curves. (auth)

20282 AUTORADIOGRAPHIC STUDIES OF LARYNGEAL BIOPSY SAMPLES. Rosemann, G. Arch. Ohren-, Nasen-, Kehlkopfheilk., 185: 704-14(1965). (In German).

A procedure for preparation of autoradiographs of laryngeal biopsy material labeled with tritiated thymidine is described. The samples are incubated in Ringer's solution containing 50 μCi of ^{3}H thymidine with sp act. of 4 mC/mmole. The tissue is cut and exposed for ~28 days to photographic emulsion. The method has proven useful for cases of squamous cell carcinomas, precancerous states, vocal chord polyps, papilloma, leucoplakia, chronic mucosal inflammation, and for marking of connective tissue. A high % of marked cells was found in carcinomas and precancerous samples. The labeling index was from less than 3 up to 6.9%. Also, there were large differences in the labeling of the chronically inflamed mucosal samples. There was a definite correlation between the labeling density and the degree of inflammatory cellular infiltration of the tissue. On the average the labeling index was less than 2%. In samples where connective tissue became labeled, fibroblasts, endothelial cells, and adventitial cells were prominent. The average index of labeling was less than 0.5%. At present this method of labeling can be improved by optimizing the permeation of the ^{3}H labeled thymidine into the tissue to obtain more uniform labeling. One practical use of the method is to study the progress of treatment of carcinomas by cytostatic agents and by irradiation. (BBB)

20283 ANNUAL REPORT ON THE HIROSHIMA ATOMIC BOMBING CASUALITY HOSPITAL. Shigeto, Fumio (Hiroshima

Atomic Casuality Hospital, Japan). Nagasaki Igakkai Zasshi, 38: Suppl., 141-5(Dec. 1963). (In Japanese).

In the past 6 years, initial visits of atomic bombing survivors were highest in 1958 and then declined steadily. In 1963, up to August 31, there were 2379 visits to the internal medicine and 393 visits to the surgery clinics. Return visits increased slightly. There were 17,456 patient visits in the internal medicine and 2,830 visits in the surgery clinics in 1962. Among the first-visit patients, leukopenia cases (less than 4000 leukocytes per mm^3) averaged 4.7%. In 1961, 3899 first-visit patients were examined in this hospital: 1646 persons under 39 years of age, 1282 in the 40 to 59 years age group, and 971 over 60 years old. Under 60-year-old female and over 60-year males were preponderant. In all, females were slightly in excess. Leukopenia showed no excess in any age group but leukocytosis (higher than 9000/mm^3) was in excess in over 60-year-old cases. Leukopenia was in slight excess, 2.5%, in the indirectly exposed group. Anemia was higher in the old-age group for both sexes. Leukocytosis and anemia were not related to the distance from the hypocenter at exposure. Hypertension and arteriosclerosis accounted for 476 cases, next in frequency were blood diseases, digestive disorders, and respiratory illnesses. Leukemia and malignancy cases were in excess in the <2-km distance-to-hypocenter group. Digestive diseases were prevalent in the proximal distance group; nephritis and nephrosis were high in the indirect exposure group. Autopsy records of exposed persons are given. Five out of 7 skin cancers developed from atomic burn keloids. Leukemia was most frequent in <2.0-km exposure distance groups. Leukemia incidence was decreased and that of other chronic diseases was increased in 1963. (BBB)

20284 SENSITIVITY OF E. COLI B TO IRRADIATION. IV. DEPENDENCE OF THE PROTECTIVE EFFECT OF CYSTEINE-CYSTEAMINE-TYPE COMPOUNDS ON PREIRRADIATION OXYGENATION AND ON PRE- AND POSTIRRADIATION CONDITIONS OF CULTURING. Hernadi, F.; Nagy, Zs.; Kovacs, P.; Valyi-Nagy, T. (Univ. Medical School, Debrecen, Hung.). Acta Microbiol. Acad. Sci. Hung., 13: 13-20(1966).

The radioprotective effects of L-cysteine-HCl, cysteamine, and d-penicillamine at concentrations of 10^{-2} M in cultures of Escherichia coli B were studied. Lethal doses of x radiation were reduced by a factor of 1.4 DRF (dose-reduction factor) by penicillamine, 1.5 DRF by cysteine, and 2.9 DRF by cysteamine. Anoxia per se decreased the sensitivity by 2.4 DRF. When cell suspensions were irradiated under anoxic conditions the radioprotective compounds tested exerted only a very slight protective effect or none at all. The effectiveness of protective substances increased when they were added to suspensions of E. coli B 10 to 60 min before irradiation and then incubated at 27 and 37°C, respectively. Cysteamine increased the DRF from 2.9 to 3.8, cysteine, 1.5 to 3.4, and penicillamine, 1.4 to 2.4. Bacteria were also irradiated under anoxic conditions and plated after an optimal postirradiation period. Under anoxic conditions the reaction period was omitted and the radioprotective substances were added to the cell suspensions 1 min prior to irradiation. The number of surviving E. coli B cells that were irradiated under anoxic conditions for 30 min at 37°C was increased when cells were incubated in the presence of cysteine-cysteamine compounds. The radioprotective effect of cysteine and penicillamine increased considerably during the post irradiation period; cysteamine exerted a slight radioprotective effect. When the compounds were added to suspensions 1 min after irradiation, the effect was similar to that observed during postincubation periods and was most pronounced when cell-suspensions had been incubated at 37°C. The radiosensitivity of cell suspensions at mid-log phase decreased by 1.5 DRF when cysteine was added just before irradiation and the suspension was plated immediately after irradiation. (BBB)

20285 CHEMICAL PROTECTION OF MEG AGAINST IONIZING RADIATION. REPORT III. RELATIONSHIP BETWEEN TIME INTERVAL FROM ADMINISTRATION OF MEG TO IRRADIATION AND ITS PROTECTIVE EFFECT. Antoku, Shigetoshi (Hiroshima Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 809-13(Oct. 25, 1963).

The radioprotective effect of β-mercaptoethylguanidine (MEG) was investigated in ddN mice given 800- or 1000-R doses of x rays 5 to 90 min after intraperitoneal injection of the drug. Estimation of the protective effect of MEG was made mainly from the 30-day mortality; mean survival time and body weight loss were also examined. In mice irradiated with 800 R, MEG had a marked effect when administered from 5 to 30 min before irradiation and most mice survived. Effectiveness of MEG decreased when administered 60 min before irradiation and no effect was observed when administered at 90 min. Although in mice irradiated with 1000 R the survival rate of protected groups was lower as compared with mice irradiated with 800 R, the effectiveness of MEG was almost as high, when administered from 5 to 30 min before irradiation. MEG was not effective when administered 90 min before irradiation. Survival time decreased with the increase of the interval between irradiation and administration of MEG. When given 20 min and earlier before irradiation, it was slightly less effective than when administered from 5 to 10 min before irradiation. Weight loss following irradiation was diminished in MEG-treated animals. (BBB)

20286 STUDIES ON LOWERING IRRADIATION DOSES TO SEXUAL ORGANS DURING UTEROSALPINGOGRAPHY. Tabuchi, Akira; Nakagawa, Shigeru; Yoshinaga, Haruma; Antoku, Shigetoshi (Hiroshima Univ.). Hiroshima Sanhujinkaikai Kaishi, 2: 59-64 (Sept. 1963). (In Japanese).

Means of improvement of irradiation technique and lowering of irradiation dose in uterosalpingography were studied and discussed. Position of the ovaries was determined by a double x-ray photographic technique in 11 subjects. A Toshi type KXO 11-8 machine was used as the x-ray source; with the subject in a recumbent position, a lead marker was placed over the position of uterus. Endografin or Moljodol was used as the contrast agent. The position of ovaries was also measured at operation in eight patients. The results showed an average depth of 8.1 cm for the right and 7.4 cm for the left ovary below the skin surface by photographic technique, and 8.3 cm for the right and 8.4 cm for the left ovary at operation. The optimum conditions for film contrast in uterosalpingography were studied. A tube voltage of 60 to 65 kvp at 200 ma-sec was used in an earlier study; under the present experimental conditions an 80-kVp tube voltage was used. The results showed that the required ma-sec value at 80 kVp was lower than that at 62 kVp and that the irradiation dose could be lowered by using high voltage, sensitivity paper, and Eastman Royal Blue film. Under these conditions the required irradiation dose was ⅛ as much as under the control conditions generally used in the uterosalpingography. (BBB)

20287 PROTECTION AGAINST THE EFFECT OF SHORT-WAVE UV RAYS ON PLANT CELLS. Biebl, Richard (Univ., Vienna). pp 283-6 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

Protective effects of thiourea against uv radiation were studied in the inner and outer epidermata of scales of Allium cepa, as well as leaf epidermata of Brassica oleracea and Rhoeo discolor. A comparison of the effects of pretreatment of 1 onion inner epiderm for 30 min with 0.1 M thiourea and of others with various other osmotically active substances such as urea, glucose, KCl, $CaCl_2$, or glycerine showed that only thiourea possessed a protective effect. The lethal irradiation duration was usually extended by 2- to 3-fold after treatment with 0.1 M thiourea, compared with the lethal duration in slices subjected to irradiation without pretreatment. The protective effect after 5 min pretreatment was only slightly less than that after 30 min pretreatment. Thus thiourea must have entered the cell in sufficient quantities very quickly. The quantity of thiourea present in the cell at the time of irradiation to exert a protective effect was studied in slices of the inner epidermis of onion scale placed in 0.001–0.5 M thiourea at pretreatment times of 30 min. When they were irradiated on filter paper soaked with solutions of the same concentrations, the limit of just noticeable protection was found at 0.05 M thiourea; 0.001 and 0.01 M thiourea were uneffective. With rising concentrations of thiourea the protective effect increased. Pretreatment in 0.5 M thiourea increased the protective effect of 0.1 M by 4 fold. Radiation-conditioned permeability and viscosity changes were not influenced in any way by thiourea. Evidently there is a difference between the uv wavelengths which cause changes in permeability and viscosity of the protoplasm and the ones causing the death of cells. (BBB)

20288 THE INFLUENCE OF THYMINE AND 5-BROMOURACIL ON THE SENSITIVITY OF ESCHERICHIA COLI TO ALKYLATION, UV, AND X IRRADIATION. Fucik, V.; Zadrazil, S.; Sormova, Zora (Inst. of Organic Chemistry and Biochemistry, Prague). Folia Microbiol. (Prague), 11: 271-6(1966).

Evaluation was made of the effects of an alkylating agent (triethylene melamine), uv, and x irradiation on the survival of Escherichia coli 15 T⁻ cells grown in a minimal medium containing an enzymatic hydrolysate of casein. Thymine-less death of most cells was observed in a culture grown in this medium. A conclusive difference in sensitivity to the lethal agents used was found between a culture grown in a thymine-less medium and bacteria grown in a medium containing excess (20 μg/ml) thymine. The culture grown with a sufficient thymine concentration was more sensitive to alkylation and x rays, whereas bacteria surviving conditions of thymine-less death were more resistant to these agents. However, such cells were more sensitive to uv irradiation. The differences found are discussed on the basis of differences in the DNA concentrations found in the individual cultures. It was found that bacteria grown in the presence of thymine contain a 2-fold higher DNA concentration as compared with thymine-starved cultures. Presumably thymine-grown bacteria terminate DNA replication in the stationary phase of

growth, whereas starving cells are blocked at the beginning of the synthetic phase. The concept that replication is blocked in different phases of the replication cycle in starving bacteria seems more logical. The difference obtained could be due to a higher DNA concentration in the cells grown in a very rich medium. (BBB)

20289 DEVELOPMENT OF RADIOACTIVE DRUGS. Mitchell, J. S. (Addenbrooke's Hospital, Cambridge, Eng.). Anglo-German Med. Rev., 2: 524-35(Sept. 1964). (In German).

Out of about 330 compounds tested for their radiosensitizing properties, Na_4 2-methyl-1,4-naphthohydroquinone diphosphate, known as Synkavite, was the most effective. Tritiated preparations of this compound were used for selective internal irradiation in clinical tumor treatment. It was possible to show that it was very rapidly incorporated into living cells, and that cultures of malignant cells contained a greater concentration of Synkavite after incubation than did normal cells. In initial therapeutic studies in patients with advanced malignant diseases, at least 9 out of 25 treated showed improvement after injection of soluble tritiated Synkavite. Doses were in the order of 3 to 10 Ci. It was calculated that 1 mCi of ^3H/g tissue produced irradiation of 293 rad within 24 hr. The biological half times of the compounds tested ranged from 3 to 13 days. For bone marrow it was about 4 days, for kidney about 6 days, and for the small intestine about 11.5 days. Doses of about 10 to 11 Ci/70 kg body wt were not toxic. Biopsies showed tissue concentrations of about 25 to 300 μCi/g. In one case of squamous cell carcinoma of the ear the biopsy specimen had a specific activity of about 9 mCi/g 30 min after injection of 10.8 Ci and 1.8 mCi/g after $3\frac{1}{2}$ hr. Irradiation dose of at least 5700 R was administered after 6 days. Tumor concentrations reached values of about 1.4 Ci/g within 30 to 40 min after administration of 10 Ci. (BBB)

20290 EFFECT OF AN ALKALINE-HYDROLYZED PRODUCT OF YEAST RNA ON THE SURVIVAL OF REPEATEDLY IRRADIATED MICE. Sugahara, T.; Nagata, H.; Tanaka, T. (Kyoto Univ.). Radiat. Res., 29: 516-22(Dec. 1966).

An appreciable prolongation of the survival time of mice exposed to repeated γ irradiation was demonstrated by treatment with a hydrolyzed product of yeast RNA (Nucleton) which is composed mainly of the four kinds of 3′-nucleotides found in RNA. From a comparison of the relative effectiveness of related compounds, it may be concluded that the effect observed is primarily due to a mixture of 3′-nucleotides. The mechanism of the effect is briefly discussed. (auth)

20291 HODGKINS DISEASE: A CLINICAL REEVALUATION AND THE RESULTS OF A LYMPHOGRAPHIC INVESTIGATION. Weissleder, H.; Stops, A. (Medizinische Univ., Freiburg i. B.). Fortschr. Geb. Roentgenstr. Nuklearmed., 106: 169-77(Feb. 1967). (In German).

The lymphographic findings in a hundred patients with Hodgkin's disease (taken from a larger series) who had been evaluated in detail are discussed. In fifty-five per cent retro-peritoneal Hodgkin's glands were demonstrated. Up to the present the extent of Hodgkin's disease has been commonly underestimated. The lymphographic findings lead to a change in the evaluation of the stage which the disease had reached in fifty-one per cent. The most important form of treatment remains radiotherapy. The scope and advantages of intralymphatic therapy are pointed out. (tr-auth)

20292 LYMPHOGRAPHIC FINDINGS OF LYMPH NODE INVOLVEMENT IN SARCOIDOSIS AND TUBERCULOSIS. Albrecht, A.; Taenzer, V.; Nickling, H. (Freie Univ., Berlin). Fortschr. Geb. Roentgenstr. Nuklearmed., 106: 178-83(Feb. 1967). (In German).

As in other diseases of the lymphatic system, lymphography can demonstrate generalized, but clinically silent, lymph node involvement in sarcoidosis and tuberculosis. The lymphographic findings in thirty-five patients with sarcoidosis and lymph node tuberculosis are described. A revision of accepted views which consider these diseases to be regional in character is required. (tr-auth)

20293 INDIRECT SPLENO-PORTOGRAPHY: METHODOLOGY, INDICATIONS, AND RESULTS. Duex, A.; Buecheler, E.; Thurn, P. (Univ., Bonn). Fortschr. Geb. Roentgenstr. Nuklearmed., 106: 183-97(Feb. 1967). (In German).

Indirect spleno-portography or arterio-venography by selective coeliac, splenic, or mesenteric arteriography is diagnostically useful in certain circumstances. This applies particularly to the diagnosis of upper abdominal tumours (pancreas, stomach, spleen) and in portal hypertension following splenectomy or splenic vein occlusion in order to assess the feasibility of an anastomosis to reduce portal pressure. Care must be taken in the interpretation of the result because of the relatively poor contrast obtained by indirect spleno-portograms, particularly in the diagnosis of hepatic tumours. Indirect spleno-portography is no substitute for the direct percutaneous method. The relevant technique is described and a special catheter is recommended: various indications are then discussed and illustrated by examples. Comparison of indirect and direct spleno-portography in the same patient should establish the value of each method. (tr-auth)

20294 NEW APPLICATIONS OF NUCLEAR-PHYSICAL MEASURING METHODS IN MEDICINE. Lorenz, W. J.; Scheer, K. E. (Deutsche Krebsforschungszentrums, Heidelberg). Fortschr. Geb. Roentgenstr. Nuklearmed., 106: 198-205(Feb. 1967). (In German).

In a general survey new applications are described of nuclear medical measurements for the visualization of quick transient changes in the distribution pattern of gamma radiation sources in organs and tissues. The most important types of chambers are described and their properties discussed. On two examples the significance of the gamma-camera for medical diagnosis is shown. At the end an assessment is given of future developments and of further applications. (tr-auth)

20295 SCINTIGRAPHY OF BONE WITH ^{85}Sr. COMPARATIVE INVESTIGATION OF X-RAY DIAGNOSIS AND SCINTIGRAPHY. Frey, K.; Sonntag, A.; Scheybani, M. Sch.; Krauss, O.; Fuchs, P. (Univ., Munich). Fortschr. Geb. Roentgenstr. Nuklearmed., 106: 206-15(Feb. 1967). (In German).

Scintigraphy of bone is indicated in cases of a negative and obscure radiological report. Processes can sometimes be better delineated on the scintigram than on the radiograph, which is important for radiation therapy. Not rarely can a greater number of metastases be detected on the scintigram than suspected from the radiograph. In 115 cases out of 133 the x ray report agreed with the scintigraphic finding. When reactions at the boundaries are absent, even extended osteolysis may not be detectable scintigraphically. Malignant and non-malignant diseases cannot be distinguished. (tr-auth)

20296 POSSIBILITIES AND LIMITATIONS OF BONE DIAGNOSIS WITH ^{85}Sr. Kolar, J.; Bek, V.; Janko, L.; Vyhnanek, L.; Babicky, A.; Drapelova, D. (Charles Univ., Prague). Fortschr. Geb. Roentgenstr. Nuklearmed., 106: 216-24(Feb. 1967). (In German).

The possibilities and limitations are discussed of the diagnosis of skeleton diseases with isotopes on the basis of 205 patients. It is emphasized that this method furnishes only indirect and non-specific information on the presence of processes in bones. The examinations with isotopes can only be evaluated in conjunction with radiographs and other clinical examinations, otherwise misinterpretation is a real hazard. The main advantages of the isotope method consist in an early and exact diagnosis of the existence and the extension of a process in a bone, particularly in parts of the skeleton which are radiologically difficult of access. Methodological indications and practical hints are given for carrying out and assessing the result of ^{85}Sr tests; the pathological and physiological bases are discussed on the basis of practical examples. (tr-auth)

20297 RADIODIAGNOSIS OF ATRIAL CALCIFICATION. Barton, A. Fortschr. Geb. Roentgenstr. Nuklearmed., 106: 241-6(Feb. 1967). (In German).

Three cases are reported in which calcified thrombus in the left atrium, or atrial appendage, was diagnosed radiologically during life. In two cases the diagnosis was confirmed at autopsy. In two patients there was extensive subendocardial calcification and calcification of the valves in addition to the calcified thrombus. Whenever there is a possibility of the presence of atrial calcification on clinical grounds, the radiologist should scan the density of the cardiac shadow with particular care. (tr-auth)

20298 MASTOCYSTOSIS AS THE ORIGIN OF GENERALIZED BONE SCLEROSIS. Loeckell, H.; Wiese, H. (Pathologische Institut des Staedt, Berlin). Fortschr. Geb. Roentgenstr. Nuklearmed., 106: 271-5(Feb. 1967). (In German).

Generalized bone sclerosis due to mastocystosis (urticaria pigmentosa) has been demonstrated radiologically in only four cases and in three of these was confirmed histologically. In the fifth case here described it has been possible for the first time to demonstrate collections of mast cells in the bone marrow in vivo. The course of the disease is described and its features discussed. Pathologically the disease is a diffuse mast cell reticulosis with increased trabeculation leading to bone sclerosis. (tr-auth)

20299 PROBLEM OF A PARALLEL PLANE RADIOGRAPH OF THE MAMMA. Lotz, K.; Tautz, M. (Staedtische Klinikum, Berlin). Fortschr. Geb. Roentgenstr. Nuklearmed., 106: 276-82 (Feb. 1967). (In German).

After an analysis of the methods in use to obtain a plane parallel body of the mamma a new method is described in which two radiographs in casettes are taken. On the film near the organ the part

near the wall of the mamma is clearly visualized; on the distant film the periphery of the mamma shows with good contrast. The results obtained by this method can be compared with those obtained by parallelism, the object range being increased significantly. The twin pictures are meant to serve a better differentiation in a mamma changed by pathological conditions. (tr-auth)

20300 PROTECTIVE EFFECT OF 5-HYDROXYTRYPTOPHAN AGAINST LETHAL DOSES OF X-RADIATION IN MICE. Kobayashi, Sadayoshi; Nakamura, Wataru; Eto, Hideo (National Inst. of Radiological Sciences, Chiba, Japan). Int. J. Radiat. Biol., 11: 505-8(1966).

In testing the radioprotective effects of 5-hydroxytryptophan (5-HTP), it was found that the optimal time of administration was about 24 min before irradiation and the optimal dose was about 0.2 mg per g. The animals had a high tolerance and good uptake of 5-HTP by radiosensitive organs. The results are discussed in comparison with effects of 5-hydroxytryptamine. (C.O.)

20301 WHOLE-BODY COUNTING STUDIES USING ^{132}Cs. Grundy, Richard D. (Dept. of Health, Education, and Welfare, Washington, D. C.); Sargent, Thornton W. J. Nucl. Med., 7: 676-86(Sept. 1966).

Detection efficiency as a function of body stature was evaluated for one-meter arc and tilting-chair counting geometries in eight volunteer subjects given known amounts of ^{132}Cs. Cesium-132 body burdens were determined in each subject 15 min, 24 hrs, and 48 hrs after injection. Urine samples were collected for analysis when possible. Biological half-life for ^{132}Cs was determined to be 50.5 days by one-meter arc geometry and 71.1 days by tilting-chair geometry. The corresponding ^{137}Cs detection efficiencies for both geometries are calculated. Using least square analysis, a correlation was performed on the ^{137}Cs detection efficiencies as a function of weight divided by height. One-meter arc geometry showed that 92% of the injected dose was retained, whereas tilting-chair geometry suggested that only 75% of the dose was retained. (H.G.D.)

20302 RADIOACTIVE SELENIUM: A NEW TRACER FOR DETECTION OF CARTILAGINOUS TUMORS. Perez-Modrego, S.; Esteban, J.; Lasa, D. (Hospital San Juan de Dios, Madrid). Brit. J. Radiol., 40: 177-80(Mar. 1967).

Selenium-75 follows the same metabolic route as sulphur, is a γ emitter, and is easily detected with normal scintillation equipment. When injected into rats intraperitoneally a very high excretion rate was noted, (45 per cent within the first 24 hours). In the series of cartilaginous tumors studied, all histologically proven, selenium in the form of sodium selenium was injected intravenously. In patients with malignant cartilaginous tumors an increase of activity of the tumor areas was noted in relation to the contralateral area. Twenty-four hours following an injection, the background activity diminished considerably and the difference of activity between the tumor and the surrounding tissues was sufficiently raised to allow scanning of the area. In malignant tumors the relation between the activity over the tumor area and the symmetrical area is always above 1.5 and tends to increase to a factor of 2 or 3, whereas in benign tumors it is below 1.5 and remains level during the following days. (auth)

20303 TOWARDS A NEW SYSTEM IN CURIETHERAPY (ENDOCURIETHERAPY AND PLESIOCURIETHERAPY WITH NON-RADIOACTIVE PREPARATION). Pierquin, B.; Dutreix, A. (Institut Gustav Roussy, Villejuif, France). Brit. J. Radiol., 40: 184-6(Mar. 1967).

Preparation for tissue implants, using non-radioactive guiding gutters, plastic tubes, and hollow needles, leads to a new system of Curietherapy with radioactive sources other than radium. A series of rules for source distribution and dosimetry in such a system is given. (auth)

20304 PREPARATION, DISTRIBUTION, AND UTILIZATION OF ^{99m}Tc-SULFUR COLLOID. Stern, H. S.; McAfee, J. G.; Subramanian, G. (Johns Hopkins Univ., Baltimore). J. Nucl. Med., 7: 665-75(Sept. 1966).

Preparation and testing of ^{99m}Tc-S colloid are described. Preparation consisted of a simple reduction of pertechnetate with acid and sodium thiosulfate in the presence of either gelatin or carboxymethylcellulose (CMC). Thiosulfate is rapidly converted to thiosulfuric acid which immediately decomposes to liberate sulfur and sulfur dioxide. The method is fairly rapid (less than one hr), requires no column purification, and can be terminally sterilized by autoclaving when CMC is used, or made under sterile conditions when gelatin is employed as the stabilizer. Distribution of the preparation was studied in mice. (H.G.D.)

20305 VALUE AND LIMITATIONS OF BRAIN SCANNING. A REVIEW OF 401 CONSECUTIVE CASES. Allen, Marshall B. Jr.; Dick, Donald A. L.; Hightower, Samuel J.; Brown, Mark (Medical Coll. of Georgia, Augusta). Clin. Radiol., 18: 19-27 (Jan. 1967).

The authors present their experience with scanning 401 patients over a 5 year period, using RISA, Hg 203, and Hg 197. With 65 proven tumors, 72% of scans were positive, 7% suspicious, and 21% negative. Lesions limited to the cerebral hemispheres were positive in 83% with an additional 5% suspicious. Scan findings were correlated with the findings of other neurological investigations. Scanning is useful for investigating non-neoplastic lesions. Chronic subdural hematomas were identified in 5 of 6 patients and suspected in the sixth. Scans on intracerebral hematomas were less revealing and uncomplicated subarachnoid hemorrhages were not identified. Completed strokes were positive in 19 of 37 patients (51%). Intermittent vascular insufficiency was suspected in 5, negative in 14 and positive in one. Three proven abscesses were positive. Scanning may aid in demonstrating and following localized cerebritis; in all 11 patients the scan was positive or strongly suspicious. The aetiology of the positive brain scan is discussed. Limitations are presented and possible means of enhancement are suggested. (auth)

20306 DELAYED MORTALITY AFTER MID-LETHAL EXPOSURES TO WHOLE-BODY IRRADIATION AND ITS MODIFICATION BY TREATMENT WITH SYNGENEIC LYMPH-NODE OR BONE-MARROW CELLS. Barnes, D. W. H.; Bungay, G. T.; Mole, R. H. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 11: 409-27(1966).

Deaths between 25 and 275 days after mid-lethal x-irradiation were closely reminiscent of the "secondary disease" of supralethally irradiated mice given allogeneic or xenogeneic cells. One-third of the mice with the diarrhea syndrome died of it; the majority recovered spontaneously. The delayed mortality was prevented and diarrhea minimized by treatment with 10^7 syngeneic lymph-node cells either soon after irradiation or 22 days later. Thus death from lymphoid insufficiency is a specific consequence of whole-body irradiation by mid-lethal doses. Radiation-induced somatic mutation in surviving cells may play a part. Early treatment with 5×10^6 syngeneic bone-marrow cells was also effective. Bone marrow at 22 days had less effect on diarrhea and did not decrease mortality but changed the post-mortem findings, death occurring characteristically with markedly congested lungs and with amyloid deposits in spleen and liver. Body weight was increased but not restored to normal by treatment with either kind of cell at either time. Survivors after 1100 rads plus bone marrow all died at about 6 months with dyspnea, pleural effusion and an enlarged heart. This specific radiation-induced syndrome killed at later times after lower radiation doses and overall its incidence was markedly dose dependent. 10^7 syngeneic lymph node cells did not modify its frequency or time of occurrence. (auth)

20307 HYDRAULIC LIFTING TROLLEY FOR A HIGH-PRESSURE OXYGEN CHAMBER. Stewart, F. S. (Mount Vernon Hospital, Northwood, Eng.). Brit. J. Radiol., 40: 134-7(Feb. 1967).

A description is given of a trolley incorporating a hydraulic lift, which facilitates the setting-up of radiation beam treatments in a high-pressure oxygen chamber used in conjunction with a linear accelerator of isocentric type having a fixed height of rotational center. Use is made of a synchronised pair of hydraulic jacks acting on two independent sliding frames at the ends of the trolley. As compared with a design employing a single jack, this arrangement avoids the difficulty of constructing a parallel motion system which would perform satisfactorily under the stresses imposed on the structure by inequalities in floor level. The design further provides ample ground clearance and so eliminates the necessity to retract the supporting ram of the normal couch during oxygen treatments. (auth)

20308 RADIOBIOLOGICAL ASPECTS OF PREOPERATIVE IRRADIATION. Nias, A. H. W. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol., 40: 166-9 (Mar. 1967).

The various combinations of radiotherapy and surgery are discussed. Postoperative irradiation cannot influence distant metastases occurring at the time of operation. High dose preoperative irradiation may delay operation and allow regrowth of surviving cells. Low-dose preoperative irradiation permits immediate operation. Preoperative irradiation will only be useful in clinical situations where there is a significant incidence of local recurrence and/or where a significant proportion of distant metastases occur at the time of operation. Cancer cells disseminated at operation, either locally or distantly, will be oxygenated and radiosensitive. Radiobiological evidence is presented on wound healing, distant metastases, and local recurrence. It is concluded that a single dose of 500 to 1,000 rads should be delivered immediately before surgery; ideally on the same day. (auth)

20309 THE EFFECT OF HETEROLOGOUS RIBONUCLEIC ACID ON THE IRRADIATED AND ON THE NON-IRRADIATED SOLID EHRLICH TUMOR OF THE MOUSE. Giudici, G.;

D'Acunzo, L.; Pini, M. (Istituto di Radiologia e Radiooncoterapico, Ospedale Maggiore, Trieste, Italy). Med. Nucl. Radiobiol. Lat., 8: 227-31(1965). (In Italian).

A report is given of the results of a study of the growth of the solid form of the Ehrlich ascites tumor in the mouse after treatment with RNA, which had proved, in other experiments, to exert an appreciable effect on recovery from radiation injury. The findings obtained (absence of protection of the tumor, and lack of growth tendency) support speculations in regard to the use of the substance in the treatment of human tumors. (auth)

20310 ISOTOPE CIRCULOGRAPHY IN VASCULAR DISORDERS OF THE BRAIN. Kvicala, V.; Henner, K. (Charles Univ., Prague). Cas. Lek. Cesk., 105: 1172-6(Oct. 1966). (In Czech).

Changes in the brain radiocirculogram caused by vascular cerebral lesions are discussed. The method is based on the use of serum albumin containing ^{131}I which is administered intravenously, and the activity in the frontotemporal area is directly recorded. Changes in the recorded curves due to atherosclerosis, brain artery occlusions, occlusion of a. carotis interna, and to arteriovenous aneurysm are discussed. Isotope circulography has the advantage of not affecting the patient and giving an objective picture of brain circulation. (CFSTI)

20311 PRELIMINARY REPORT OF USING ^{90}Sr IN THE TREATMENT OF SKIN DISEASES. Shih, Jui; Tseng, Hsi-lan; Huang, Kuo-hua; Lin, Tse; Wang, Pao-tsung (Chung-shan Medical Coll., Canton, China). Chung Hua Fang She Hsueh Tsa Chih, 8: 117-20; 148(Apr. 1960). (In Chinese).

The paper reports the results of radiotherapy of 58 cases of skin diseases with ^{90}Sr. The ten types included (a) 30 neurodermatitis, (b) 8 chronic eczematous dermatitis, (c) 2 severe erythema multiforme exudativum, (d) 2 balanoposthitis erosiva, (e) 2 erythema, (f) 7 external hemorrhoid, (g) 1 erythema nodosum, (h) 3 rhinophyma, (i) 1 psoriasis, and (j) 2 eczema of the hands and feet, of which better results were obtained in treating (a), (c) and (d). The paper is of the belief that the cure by ^{90}Sr is due to the direct action of its beta rays upon the nervous receptors in the skin causing transient inhibition of conductivity of the nervous analysor thus resulting in the disappearance of the clinical symptoms and then recovery. The authors have described in detail the doses, the methods and the courses of the treatment, the protecting materials such as aluminum, lead and rubber for the patient and also discussed briefly the combined treatments with other therapies. Seven photographs are provided with one showing the ^{90}Sr applicator and two each showing type (c), (d) and (f) before and after the treatment. (CFSTI)

20312 PLANNING GUIDE FOR RADIOLOGIC INSTALLATIONS. SECOND EDITION. Scott, Wendell G. (ed.). Baltimore, Williams and Wilkins Co., 1966. 308p. $9.50.

A guide is presented for planning for radiologic installations in hospitals. The guide is based on the use of new developments in diagnostic radiography, therapeutic radiography, applications of radioisotopes in diagnosis, cardiovascular and cerebral angiographic examinations, venography, lymphongiography, and the use of image intensifiers and cine attachments with television circuitry for distant reception of the fluoroscopic image or the monitoring of patients in isolated rooms, teletherapy with ^{60}Co and ^{137}Cs, the substitution of ^{60}Co and ^{137}Cs for Ra in contact and interstitial radiotherapy, and the use of megavoltage generators for radiotherapy. A check list of essential and optimal facilities and equipment is included. (C.H.)

20313 THERAPEUTIC RADIOLOGY. RATIONALE, TECHNIQUE, RESULTS. Second Edition. Moss, William T.; Ackerman, Lauren V. St. Louis, C. V. Mosby Co., 1965. 527p. $18.75.

General concepts of therapeutic radiology are reviewed. The merits and contraindications of radiotherapy of cancers of various organs are discussed and ideal results as well as the complications to be expected under certain circumstances are described. Combinations of radiotherapy and surgery, using either preoperative or postoperative irradiation, are also described. (1051 references). (C.H.)

Radiation Effects on Animals

Refer also to abstracts 20038–20041, 20044, 20045, 20080, 20110, 20122, 20127–20129, 20143, 20219, 20220, 20233, 20247, and 20306.

20314 (AD-633201) ^{59}Fe AND ^{51}Cr STUDIES OF THE EFFECT OF PARTIAL-BODY X-IRRADIATION ON ERYTHROPOIESIS IN BEAGLES. Penikas, Vincent Thomas (Rochester Univ., N. Y. School of Medicine and Dentistry). 1966. Contract AF 33(608)-1272. 256p. CFSTI $3.00 cy, $0.65 mn.
Thesis.

In beagle dogs that received partial-body exposures of 1000 KVp X-rays, alterations in erythropoietic activity were studied using ^{59}Fe as a tracer. Chromium-51 was used to estimate erythrocyte life span and the rate of loss of red cells from the circulation following exposure. Three groups of dogs were exposed to 1700 R to the upper-body, one group to 400 R to the upper-body, one group to 400 R to the lower-body, and a sham-irradiated group was used as a control. In an attempt to determine the degree of erythropoietic activity in the irradiated bone marrow during the period of rapid recovery after an upper-body exposure to 1700 R, two groups received an additional exposure of 400 R to either the upper or lower-body 14 days after initial 1700 R exposure. Ferrokinetic data among the various groups were analyzed and compared. (TAB)

20315 (COO-1024-22) A COMPARISON OF THE CYTOLOGICAL EFFECTS PRODUCED BY IONIZING RADIATIONS OF DIFFERENT L.E.T. Six Year Summary of Activities. [Riley, Edgar F.] (Iowa Univ., Iowa City. Radiation Research Lab.). Mar. 1967. Contract AT(11-1)-1024. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on studies initiated to determine: why some radioinduced cataracts progress to a complete opacification of the lens while others do not; why the fractionation of a cataractogenic dose of x radiation decreases the effectiveness of the irradiation so much more than a similar fractionation of a cataractogenic dose of neutron irradiation; and the effects of γ or x radiation on the photoreceptor systems of the eye. A lead shield was devised that permits irradiation of one-half of a rat eye with considerable precision. Techniques were worked out for $^{3}HTdR$ labeling of the epithelial cells and for making autoradiographs of whole-mount preparations of the lens epithelium. A satisfactory method was found for counting the tritium in aqueous humor using a liquid scintillation system. Assay of the radioactivity in the aqueous humor showed a maximum at about 2.5 min after injection, about 90% being cleared out of the aqueous humor within 20 min after injection. Subsequent experiments showed that the duration of the cell cycle was at least 22 hrs and probably was about 30 to 32 hrs. Therefore, it was confirmed that pulse-labeling of epithelial cells had occurred. Characteristics of the cell populations in the normal lens epithelium of the rat were determined in animals 3.5 to 4.0 mos of age. Three distinct cell populations were defined. From studies of dose-effect relationships, it was found that a single x-ray dose of 600 rad and a single neutron dose of 100 or 150 rad produced cataracts that did not progress beyond stage I during the first 9 mos post-irradiation. X-ray doses of 1000 and 1200 rad and neutron doses of 250 and 300 rad produced complete opacification of the lens at about 10 months after exposure. Effects of single doses of x radiation to the entire eye or to one-half of the lens indicated that the depletion of the cell populations in the irradiated half of a lens paralleled that observed when two halves were irradiated, for the first 6 months post-irradiation. During the next 6 months, however, there was little additional depletion of the cell populations if only half of the lens was irradiated, in contrast to a continuation of the depletion when all of the lens was irradiated. No significant depletion was noted in the shielded half, and it appeared that no increase in the production of new cells in the shielded half nor export of cells from the shielded half to the damaged half of the lens epithelium had occurred. (H.G.D.)

20316 (COO-1201-10) EFFECTS OF RADIATION ON DEVELOPMENT AND ORGANIZATION OF THE MAMMALIAN NERVOUS SYSTEM. Technical Progress Report. Hicks, Samuel P. (Michigan Univ., Ann Arbor. Dept. of Pathology). Feb. 1967. Contract AT(11-1)-1201. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on studies on the effects of various doses of x radiation during infancy on the development of the nervous system of rats. Serial microscopic sections of the brains of rats exposed to 200 R on the fifth day after birth were prepared from the time of irradiation to maturity and examined for evidence of the effects of radiation on the differentiation of each of the cerebellar cell types. Autoradiograms prepared from microscopic sections of brains of rats given tritium when 5 days old and irradiated at selected times were also examined for evidence of radiation effects on cell differentiation and the movement of primitive cells in the developing cerebellum. The effects of exposure to doses of 200 R on the 17th intrauterine day or to various doses of x raciation to certain regions of the brain or body on the 1st, 3rd, or 6th day after birth on adult behavior were studied on slow motion moving pictures begun in infancy and continued into adult life. Abnormalities of motor behavior were related to malformations of the cerebellum in some cases. Preliminary observations on radiation effects on the adaptation of rats to restricted daily access to food are also reported. (C.H.)

20317 (COO-1209-1) TECHNICAL PROGRESS REPORT, JUNE 15, 1966–MARCH 1, 1967 [ON EFFECTS OF X-RAYS ON HISTOMONAS MELEAGRIDIS AND HETERAKIS GALLINARUM].

Hansen, M. F. (Kansas State Univ., Manhattan). Mar. 7, 1967. Contract AT(11-1)-1209. 11p. DTIE.

Progress is reported on studies on the effects of various doses of x or γ radiation on the infectivity of Histomonas meleagridis, a flagellate, in turkeys and the effects of various doses of x radiation on the infectivity of Heterakis gallinarum, a nematode, in chickens. Doses of 150 to 200 Kr x radiation were required to retard the growth of Histomonas exposed in culture media. Increased radiation dose increased the time before signs of infection were observed in turkeys inoculated rectally with irradiated Histomonas. Irradiation with ^{60}Co γ radiation proved more satisfactory than x radiation for cultured Histomonas. Latent effects of x radiation on Heterakis gallinarum were demonstrated when chickens were inoculated by mouth with irradiated eggs. Only two generations of worms developing from irradiated eggs survived. (C.H.)

20318 (COO-1210-27) THE EFFECTS OF IRRADIATION ON ERYTHROCYTE CHIMERISM AND IMMUNOLOGIC TOLERANCE IN CATTLE TWINS. Technical Progress Report No. 5, March 15, 1966–March 15, 1967. Stone, William H. (Wisconsin Univ., Madison. Lab. of Genetics. UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Contract AT(11-1)-1210. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experiments on the effects of γ irradiation on the proportions of the two red blood cell types in chimeras showed that fractionated doses of whole body irradiation were much more efficient in causing shifts than single doses. After a change in proportions the cells may return to the original proportions. The proportions of the two cell types in both members of a twin pair similarly treated shifted in the same direction following irradiation. A marked lymphopenia occurred in 13 chimeras given extra-corporeal irradiation of the blood, but there were no shifts in the proportions of the two cell types in these animals. The majority of co-twin skin grafts were rejected whether or not the host was irradiated. This indicated that the chimeras were only partially tolerant to each other's skin. Four twins were given 5-fluorouracil; only one animal showed a slight shift in cell proportions. Similar results were obtained with 6-mercaptopurine. Three pairs of twins were treated with ^{90}Sr; two sets of these died 17 weeks post-treatment. The surviving twins showed significant shifts in blood proportions. ^{75}Se was used as a tracer for studies on relative rates of formation and destruction of the two types of cells. These experiments were repeated using ^{59}Fe. Passive transfusion experiments were carried out on two animals each with an antiserum specific for one of its two cell types. Karyotype analyses were made using leukocytes. Twelve co-twin kidney transplantations were carried out; seven are surviving and functioning after more than one year. Studies on a technique for isolating bovine lymphocytes for in vitro histocompatibility testing and leukocyte typing are in progress. (H.L.W.)

20319 (NYO-2785-1) THE TUMORIGENIC ACTION OF BETA, PROTON, ALPHA, AND ELECTRON RADIATION ON THE RAT SKIN. Progress Report. Albert, Roy E. (New York Univ., N. Y. Dept. of Environmental Medicine). Jan. 10, 1967. Contract AT(30-1)-2785. 218p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on studies on the induction of tumors of rat skin by exposure to β, proton, α, or electron radiation. Results of the studies indicated that the dose-response curve for tumor induction is very complex and not consistent with a simple somatic mutation hypothesis. With increasing doses, the tumor incidence rises geometrically until a maximum is reached where further increases in dose actually reduce the tumor yield. Some dependence of the morphology of the tumors on the radiation dose and a correlation between the production of gross skin damage and tumor formation were found. Results are summarized from studies on skin tumor induction by 40 MeV α particles and 0.35 MeV electrons in which the influence of LET was considered. The RBE for tumor induction of α particles with respect to electrons was estimated to be about 3.7. Preliminary observations indicated that the RBE for cell killing may differ from that for tumor induction, that the tumor incidence is maximum when the Bragg peak is placed at a skin depth of about 0.3 mm, and that grid and sieve irradiation patterns may afford a significant protection against tumor induction. The morphology and growth characteristics of radiation induced skin tumors were also studied. It is pointed out that rat skin tumors resemble human skin tumors. Eight publications that report results of previous studies are appended. (C.H.)

20320 (NYO-3355-12) EFFECT OF RADIATION ON TISSUE PROLIFERATION STUDIED IN ORGANOTYPIC CULTURES. Borghese, Elio (Naples Univ. (Italy). Istituto di Anatomia Topografica). Oct. 1966. Contract AT(30-1)-3355. 13p. (CONF-661117-1). DTIE.

From International Conference on Radiation Biology and Cancer, Kyoto, Japan.

A review is given of the results obtained by the author and his collaborators on the effect of ionizing radiation on viability and reproduction of cells belonging to developing organs, explanted from mouse embryos, submitted to gamma rays of ^{60}Co or to x rays, and cultured in vitro. The data so obtained are fairly reproducible, and in some conditions capable of being quantitatively analyzed. Limb buds explanted at the stage in which cartilages are being formed, showed a clear-cut distinction between a resistant cartilage and a sensitive mesenchyme. Lungs, taken from embryos when the epithelial tree starts branching, showed an inhibition of ramification with partly reversible epithelial damage, and a late more severe mesenchymal degeneration. Quantitative research on cellular deaths, studied by counting degenerated cells or by survival curves in organs fixed at time intervals as long as 36 hours post-irradiation, showed in limb buds a peak of degenerations at 10–12 hours, in lungs a 50% survival of cells at 4 hours. Counting of mitoses revealed a mitotic delay, characterized by a drop in the number of mitotic cells to zero at 4 hours post-irradiation followed by a temporary increase above the normal level. Growth of lung epithelial tree, estimated in living cultures by measuring its area at time intervals, gave a correlation between effect and dosage, in the range of 50 to 400 R; at the lowest doses an indication of recovery was found at 30 hours post-irradiation. (auth)

20321 (ORO-653) SEMIANNUAL PROGRESS REPORT (ON AGRICULTURAL RESEARCH), JANUARY 1–JUNE 30, 1966. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Feb. 1967. Contract AT(40-1)-Gen-242. 116p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported of studies on: prenatal studies, including somatic changes in the fetus and placental transfer and fetal physiology; reproduction, including effects of radiation upon reproductive biology; lifetime reproduction herd; pathology of life time reproduction herd; late effects, including late effects of irradiation in large animals; pathology report; late effects of whole-body gamma irradiation on the work performance and related physiology of Shetland ponies; tumorigenesis in rats; exsanguino-transfusion in sheep; early effects, including dizygotic twin cattle and tissue tolerance and end products in blood and urine following whole-body irradiation; tissue culture; pathology; nutrition, including swine, sheep and beef cattle phase; radioiodine and dairy cattle; radiocerium as a non-absorbed reference material for determining gastrointestinal sites of mineral absorption and excretion in cattle; radiotoxicity in poultry; metabolism of fission products and related nuclides in poultry; soil chemistry, including properties of clay systems controlling ion exchange kinetics and ion exchange equilibrium; diffusion in nonidealized systems; specific reactions affecting cation availability in clay minerals; plant studies, including genetic control and environmental modification of seed radiosensitivity; mutation in quantitatively inherited traits; irradiation of interspecific hybrid zygotes and proembryos; radiation effects on horticultural plants. (S.M.A.)

20322 (ORO-2575-32) STUDIES OF EARLY EFFECTS OF RADIATION ON CHROMOSOMES AND MITOSIS. Progress Report, March 1, 1966–February 28, 1967. [Carlson, J. Gordon] (Tennessee Univ., Knoxville. Inst. of Radiation Biology). Contract AT(40-1)-2575. 4p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effects of various wavelengths of monochromatic uv radiation on mitosis and the incorporation of tritiated thymidine in the nucleus of grasshopper embryos in hanging drop cultures were evaluated in autoradiograms. Preliminary results suggest that at least a portion of the induced incorporation of tritiated thymidine is not simply repair of directly damaged DNA. Electron microscope studies of early morphological effects of x radiation on the internal structure of chromosomes of grasshopper neuroblasts were continued and method of sample preparation are discussed. A preliminary study indicated that the addition of actinomycin-D to the culture media blocked the uptake of tritiated uridine (RNA synthesis) in neuroblasts. (C.H.)

20323 (PEL-130) RADIOISOTOPES AND RADIATION IN HELMINTHOLOGY. A Bibliography. Rossouw, S. F. (comp.) (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Oct. 1966. 29p. Dep. mn.

Eighty-seven references are presented to literature published between 1948 and 1966 on the use of radiation and radioisotopes in the control of helminthic diseases in man and animals. (C.H.)

20324 (RM-4706-TAB(Pt.1)) SENSITIVITY OF MORTALITY ESTIMATES TO UNCERTAINTIES IN SOME NUCLEAR DAMAGE PARAMETERS. Arnsten, Michael E. (RAND Corp., Santa

Monica, Calif.). Nov. 1966. Contract AT(04-3)-414. 126p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Factors that would affect mortalities of the civilian population in the event of nuclear warfare are reviewed. Estimates of the lethality of nuclear radiation are examined to indicate the range over which these estimates are scattered. Estimates of the quantity and distribution of radioactivity are discussed. These estimates are used to predict the outcomes of hypothetical nuclear attacks on the United States. The mortalities due to instantaneous and protracted radiation exposure are predicted from three different counterforce attacks, computed for three different winds, and varying the lethality parameters in turn. The values chosen for the parameters used in the calculations were not at the extreme end of the quoted regions of uncertainty, except for biological recovery. (83 references.) (C.H.)

20325 (RM-4707-TAB(Pt.2)) SENSITIVITY OF MORTALITY ESTIMATES TO UNCERTAINTIES IN SOME NUCLEAR DAMAGE PARAMETERS. Arnsten, Michael E. (RAND Corp., Santa Monica, Calif.). Nov. 1966. Contract AT(04-3)-414. 143p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The lethality of instantaneous and protracted radiation exposure during hypothetical 8500 and 3500 MT ground burst nuclear attacks on military targets in the U.S.A. was estimated for various meteorological civilian defense and military conditions. Three graphs were calculated using three different damage functions relating the incidence of radiation mortalities to the radiation dose. The use of a computer for calculating fallout mortalities from data on the radiation dose and wind pattern at various monitoring stations is discussed. (C.H.)

20326 (RM-5083-TAB) LONG-TERM RADIATION DAMAGE: EVALUATION OF LIFE-SPAN STUDIES. Brown, Bernice (RAND Corp., Santa Monica, Calif.). Dec. 1966. Contract AT (04-3)-414. 70p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An exploratory review, from the viewpoint of a statistician, of part of the literature on radiation life shortening is presented. It examines some of the experimental data on response of animals to whole-body exposure to a single acute dose of x rays. It evaluates interpretations of the observed data and summarizes what seems pertinent in regard to life shortening. Some of the methods suggested for estimating life shortening in man from observed data on experimental animals are discussed. A description is given of some of the models used to study radiation injury and recovery. There is a discussion of the differing points of view in the general theories of the aging process which are in the background of the development of models for studying radiation effects. From the analysis of selected data on life shortening from a single acute exposure, there are three conclusions dealing with laboratory mice and rats: (1) If adult animals (age 3-4 months) are irradiated, life shortening increases roughly linearly with dose. (2) If dose is kept constant at 500 R, animals exposed at an early age experience a greater life shortening than those exposed later in life, with life shortening decreasing roughly linearly with age at time of exposure. For animals of age 4 months exposed to 500 R, life shortening is approximately 0.3 to 0.4 days per R. For a single acute exposure, the estimates of life shortening in man, obtained by extrapolation from animal experiments, range from 7 to 12 days per R. (auth)

20327 (TID-23636) LONG TERM EFFECTS OF PRENATAL X-IRRADIATION ON CEREBRAL CORTEX. Technical Progress Report, December 1, 1965-December 1, 1966. Brizzee, Kenneth R. (Utah Univ., Salt Lake City. Coll. of Medicine). Jan. 1967. Contract AT(11-1)-1474. 32p. DTIE.

Progress is reported on studies on the long-term effects of prenatal x irradiation on rats. Data are included on the effects of 90 R or 130 R x radiation on the morphology of rat brain; histological studies of evidence of cell recovery in fetal brain tissue following whole-body x radiation of pregnant rats; the effects of prolonged low-dose γ radiation on ultrastructural changes and cell replication cycle in fetal rat brains, and the effects of whole-body exposure of pregnant rats to doses of 130 R x radiation on the 13th day of gestation on the behavior of offspring as revealed by response to certain standard tests, such as righting reflex when dropped, jumping from heights, and sensitivity to foot shock. (C.H.)

20328 (USNRDL-TR-67-23) POSTIRRADIATION LEUKOCYTE PATTERNS IN MICE AND DOGS TREATED WITH ENDOTOXIN. Ainsworth, E. J.; Mitchell, F. A. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 20, 1967. 31p.

Studies were conducted to evaluate the effect of endotoxin on the return of leukocyte counts toward normal in irradiated mice and dogs. Typhoid-paratyphoid vaccine was used as the source of endotoxin, and animals were injected 24 hours before irradiation. The data show that endotoxin-treated animals had higher numbers of circulatory granulocytes than did controls between approximately 7 and 17-21 days after irradiation. The pattern of the return of granulocyte counts toward normal in endotoxin-treated animals was characterized by a large rise during the second week which coincided in time with the abortive rise observed in nontreated animals. The granulocyte counts in endotoxin-treated animals declined after the period of the abortive rise but remained higher than in the nontreated controls and returned to normal earlier than did the counts of the controls. The influence of endotoxin in postirradiation leukocyte counts was not restricted to granulocytes since during the abortive rise period the lymphocyte counts were also increased. Speculation is offered relating to the mechanism by which endotoxin influences postirradiation leukocyte counts. (auth)

20329 (USNRDL-TR-1111) RECOVERY FROM RADIATION INJURY IN THE HAMSTER AS EVALUATED BY THE SPLIT-DOSE TECHNIQUE. Holloway, Roy J.; Leong, George F.; Ainsworth, E. John; Albright, Marion L.; Baum, Siegmund J. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 20, 1966. 32p. CFSTI $3.00 cy, $0.65 mn.

The split-dose technique was used to determine the pattern of recovery from radiation injury in the Syrian hamster (Mesocricetus auratus). Exposure of the animals to Mvp x rays resulted in a $LD_{50\ 30}$ of 941 R (95% confidence interval: 917-967 R). Recovery, defined as a return to normal radiosensitivity after a sublethal exposure, was found to be nonexponential; in fact, a marked transient increase in radiosensitivity was observed during the second week. After exposure to $\frac{2}{3}$ $LD_{50\ 30}$, relatively little recovery was observed on the 3rd day after the conditioning exposure—94% of the initial injury remained. Between the 3rd and 7th day the hamster recovered at a rapid rate—only 26% of the initial injury remained on day 7. These periods of recovery were followed by a regression of the animals to a more radiosensitive state—76% of the initial injury was present on day 11. After this time, the animals returned toward more nearly normal radiosensitivity—20% of the initial injury remained at day 20. These findings are a marked deviation from the exponential recovery pattern usually reported for other rodents. Hematological studies indicate that the extent of recovery, in terms of split-dose radiosensitivity, is not correlated with the number of circulating erythrocytes, thrombocytes, granulocytes, or mononuclear cells. Survival time was found to be inversely related to exposure—the higher the exposure, the shorter the survival time—in all irradiated groups except the group challenged at 3 days. The interpolated survival time at the LD_{50} exposure varied with the day of challenge: 13.7 days at day 0, 11.1 at day 3, 14.1 at day 7, and 17.2 at day 11. (auth)

20330 (AEC-tr-6771) RADIOBIOLOGY. Translation of Radiobiologiya, 6: No. 2, 161-336(1966). 251p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

20331 (NP-tr-1481) ROLE OF PEROXIDES AND OXYGEN IN THE FIRST STAGES OF THE RADIOBIOLOGICAL EFFECT. THE PHENOMENON OF THE OXYGEN AFTER-EFFECT IN RADIOBIOLOGY. Eidus, L. Kh. Translated by A. Crozy (Atomic Energy Research Establishment, Harwell, Eng.), from pp 136-45 of Rol' Perekisei i Kisloroda v Nachal'nykh Stadiiakh Radiobiologichesogo Effekta, Izdatel'stro Akademmi Nauk SSSR, Moscow, 1960. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Various theories as to the role of oxygen in the enhancement of the effects of ionizing radiation on biological systems are discussed. It is pointed out that until recently it was assumed that the effect was due to the participation of oxygen in water radiolysis and the formation of the HO radical. Other possible explanations are discussed. Results are reported from studies on the effects of radiation on myosin solutions that indicate the existence of an oxygen effect not connected with the radiolysis of water. (TSS)

20332 EFFECT OF CALCIUM ON MITOSIS IN THE THYMUSES OF NORMAL AND IRRADIATED RATS. Perris, A. D.; Whitfield, J. F. (National Research Council, Ottawa). Nature, 214: 302-3(Apr. 15, 1967).

The demonstration that increased calcium levels in cultures of strain L mouse fibroblasts and rat thymocytes stimulated mitosis and reduced, or prevented, the transient mitotic delay produced by irradiation, led to the hypothesis that a rise of calcium concentration in the blood and tissues might also stimulate normal mitosis and reduce post-irradiation mitotic delay in the whole animal. In order to test this, intraperitoneal injections of a concentrated calcium chloride solution were given to rats immediately after whole-body irradiation with ^{60}Co gamma radiation. Unirradiated rats were given similar injections. The effects on mitosis in the thymus were determined by injecting colchicine intraperitoneally immediately after irradiation and then estimating the subsequent rate of accumulation of cells in metaphase. For unirradiated rats the number of cells in metaphase increased approximately linearly with time. Irradiation with 200 rads markedly reduced the rate of

entry of cells into mitosis. The ability of calcium to mitigate the inhibitory effect of radiation on mitosis is probably due to prevention of the disaggregation of condensed chromatin structures which follows irradiation of thymocytes. Raising the calcium level in animals after irradiation, either directly by injection of calcium salts, or indirectly by injection of parathyroid hormone, increases their survival, and it is suggested that this therapeutic effect may be a result of mitotic stimulation in those highly radiosensitive tissues the integrity of which is vital for survival. (UK)

20333 ANGIOGRAPHIC INVESTIGATIONS OF THE LUNGS AFTER LOCAL X-RAY IRRADIATION. Ivashchenko, A. P. Med. Radiol., 12: No. 2, 31-8(Feb. 1967). (In Russian).

In experiments staged on 78 rabbits by means of angiocardiography the authors studied functional and anatomical radiation injuries of pulmonary vessels after the local action of different doses of x-ray radiation. Single irradiation of the entire chest in an absorbed integral dose in the lungs of 370 gm-rad in 24 hours causes congestion of the lungs. With increase of the dose up to 2,200–3,700 gm-rad the major vessels become dilated as the result of their reduced tone; the tone of small vessels increases. After single irradiation the circulation rate decelerates. With an increase of the dose of single irradiation at the beginning there occurs an acceleration of the arterial circulation and then the venous circulation, this being explained not only by dilatation of major vessels, but also by opening of arteriovenous anastomoses. In prolonged multifold irradiation of the chest with a daily dose of 3,300 gm-rad significant anatomical changes in the lungs, even radiation pneumonia, develop after irradiation of the lungs in a total absorbed integral dose of 97,200 gm-rad. Functional changes run an undulant course in correspondence with the clinical course of radiation sickness. Hemodynamic disturbances in irradiation of only one-half of the chest are at first analogous in both lungs. In doses over 33,000 gm-rad, along with general circulatory disorders in the pulmonary circulation, on the side of irradiation there appear also local changes due to anatomical injuries. Irradiation of the lung through a field measuring 2 × 2 cm causes anatomical changes in the form of deformation of small vessels and disturbance of their patency, restricted by the zone of irradiation, which are attended by mildly pronounced functional disorders. (auth)

20334 INFLUENCE OF FRACTIONAL LOCAL IRRADIATION ON THE GROWTH OF EXPERIMENTAL EPENDYMOBLASTOMA. Khalanskii, A. S.; Lyass, F. M. Med. Radiol., 12: No. 2, 38-44 (Feb. 1967). (In Russian).

Under study was the effectiveness of the action of fractional local x-ray irradiation on the growth of experimentally-induced ependymoblastoma in albino mice. Morphological changes occurring in the tumor served as a criterion. There was noted a distinct therapeutic effect which depended both upon the terms of the beginning and on the total dose of irradiation. At the beginning of irradiation at early periods (on the 6th day after grafting) a distinct inhibition was already observed when the total dose (1,000 rad) was achieved in the tumor. The tumor developed in 25 per cent of animals. When the total dose was increased to 2,000 rad the tumor developed only in one out of twelve mice. All the animals receiving a dose of 3,000 rad survived. When the irradiation was started at later periods (in 13 days) the therapeutic effect was less marked. During irradiation the neoplastic node decreased in size, areas of necrosis increased therein, and the structures characteristic for ependymoblastoma disappeared. In the cells of the tumor there developed profound degenerative-dystrophic changes characterized by the appearance of giant hyperchromous nuclei, caryorhexis or complete lysis of cells. (auth)

20335 CHANGES IN THE FUNCTIONAL STATE OF THE HEMATOENCEPHALIC BARRIER UNDER THE INFLUENCE OF X-RAY IRRADIATION. Popiashvili, N. Z. Med. Radiol., 12: No. 2, 44-7(Feb. 1967). (In Russian).

Investigations were performed in experiments staged on rabbits irradiated with doses from 400 to 1,600 R by means of the radioindication method (^{32}P). The index of permeability was the percentage ratio between the isotope in the cerebrospinal fluid and the activity of the simultaneously taken blood. It was found that the above-mentioned is one of the most sensitive methods, the effect of ionizing radiation causes a disturbance of the hemato-encephalic barrier, the degree of which depends upon the dose employed. Disturbance of the hemato-encephalic barrier is one of the early manifestations of radiation changes in the animal organism. Data of the investigation are presented in the form of curves. (auth)

20336 EFFECT OF A WHOLE-BODY GAMMA-IRRADIATION UPON THE BLOOD SERUM PROTEINS IN MONKEYS. Annenkov, G. A.; Kashkin, K. P. Med. Radiol., 12: No. 2, 54-60(Feb. 1967). (In Russian).

Under study were changes in the blood serum of macaca-rhesus occurring under the effect of a total-body irradiation in doses of 550 or 635 R. Investigations were made by paper electrophoresis in a starch gel and by immunoelectrophoresis. A tendency towards decline of the albumin content was noted. The disappearance of normal, or emergence of new antigens was not recorded. There was a varying mobility of alpha- and beta-globulins, with that of transferrin showing a particularly noticeable increase. (auth)

20337 RADIOSENSITIVITY OF THE HYPOTHALAMUS IN MEGAVOLT RADIOTHERAPY OF CEREBRAL TUMORS. Badmaev, K. N.; Samoilov, V. I. Med. Radiol., 12: No. 2, 13-17(Feb. 1967). (In Russian).

Under study were the dynamics of diencephalic tests and data of bioelectric activity of the brain in the process of megavolt radiotherapy for cerebral tumors. The data obtained testify to the relative radiosensitivity of hypothalamic formations of the brain to bremsstrahlung by betatron with an energy of 25 MeV in conditions of fractional irradiation, notwithstanding the high dose (3,500 to 5,000 rad) which falls on the hypothalamus. (auth)

20338 CHANGES IN THE CELLULAR COMPOSITION OF BONE MARROW IN MICE IRRADIATED WITH DIFFERENT X-RAY DOSES. Haot, J.; Haughton, G.; Revesz, L. (Karolinska Inst. Medical School, Stockholm). Europ. J. Cancer, 3: 67-74 (Feb. 1967).

Mice were exposed to doses of x radiation ranging from 50 to 1500 R and killed at various times after irradiation, ranging from 2 to 48 hr for short-term experiments and from 2 to 34 days for long-term experiments. Suspensions of femoral bone marrow cells, other than erythrocytes, were divided into two population sizes by the use of a particle size distribution plotter attached to a Coulter counter. The radiosensitivity of the two populations was studied independently, and the smaller cell population was found to be extremely radiosensitive, corresponding closely to radiation response of small lymphocytes from lymph nodes and spleen. The population of larger cells was much more resistant to irradiation. The recovery characteristics of the two cell populations were also different, indicating different mechanisms were involved. (C.H.)

20339 X RAY SENSITIVITY OF HeLa S3 CELLS IN THE G2 PHASE: COMPARISON OF TWO METHODS OF SYNCHRONIZATION. Djordjevic, Bozidar; Tolmach, L. J. (Washington Univ., St. Louis). Biophys. J., 7: 77-94(Jan. 1967).

The sensitivity of HeLa S3 cells to 220 kV x rays was measured in terms of cell survival (colony development) during the G2 phase of the cell generation cycle, employing two procedures designed to free G2 cultures from contaminating cells from other phases of the cycle. Treatment of synchronous cultures (obtained initially by mitotic selection) with high specific activity tritiated thymidine (HSA-^{3}HTdR) selectively eliminated S phase cells, while addition of vinblastine permitted removal of cells as they entered mitosis. It was found that HeLa S3 cells become increasingly sensitive as they progress through G2. The pattern of sensitivity fluctuations observed in synchronous HeLa S3 populations selected by the foregoing method was compared with that found in synchronous cultures prepared by the HSA-^{3}HTdR method of Whitmore. The latter method had been used previously with mouse L cells, which were found to undergo a different pattern of sensitivity fluctuations. The two methods yield similar results for HeLa cells in the S and G2 phases of the cycle. It may be concluded, therefore, that the discrepancies between HeLa and mouse L cells do not arise from methodological factors, but represent fundamental differences between the cell types. (auth)

20340 POST-RADIATION RECOVERY IN EARLY SPERMATIDS SAMPLED FROM DROSOPHILA PUPAE. Watson, William A. (Univ. of Leiden). Mutat. Res., 4: 169-76(Mar.-Apr. 1967).

When 24- and 48-hr old Drosophila pupae were subjected to 6 hr pretreatment with nitrogen, irradiation under anoxia, then post-treated for a further 2 hr with either oxygen or nitrogen, it was found that in the first one-day brood from the 24-hr pupae there was a consistent and highly significant decrease in the mutation frequency following oxygen post-treatment, as compared to that with nitrogen. The result confirms earlier findings and demonstrates the existence of an oxygen-dependent repair process operating in early spermatids of Drosophila. It was observed that more repair occurred at low than at high doses (i.e., the relative reduction in mutation frequency was greater), and the suggestion is put forward that the repair system can handle effectively only a limited amount of damage, but becomes saturated when this amount is exceeded at higher doses. The fact that translocation frequencies are also lowered by oxygen post-treatment is taken as an indication that potential breaks, rather than chromosome breaks, are involved in the repair process. Dominant lethal studies showed that it is most unlikely that the repair process could be due to an artefact caused by oxygen selectively eliminating cells carrying mutations. (auth)

20341 INDUCTION OF TOLERANCE TO MATERNAL TISSUE HOMOGRAFTS BY IRRADIATION OF THE PLACENTA. Ramseier, H.; Brent, R. L. (Jefferson Medical Coll., Philadelphia). Ann. N. Y. Acad. Sci., 129: 241-9(Dec. 30, 1966). (NYO-2071-33).

Transplantation tolerance has been demonstrated in (DA × Lewis)F_2 hybrid rats whose mothers' placentas were x irradiated on the 15th day of gestation. Irradiation is presumed to have increased transplacental passage of maternal cells and was expected to result in tolerance of both DA and Lewis isoantigens. Comparison of the results with those of a control study showed that only tolerance of DA antigens could be induced under the conditions of the experiment. This tolerance was significant and permanent. On a population level, it probably involved only 2 of the 6 to 7 independently segregating histocompatibility loci by which the rat strains DA and Lewis differ. (auth)

20342 INFLOW OF BONE MARROW CELLS TO THE THYMUS: STUDIES WITH PART-BODY IRRADIATED MICE INJECTED WITH CHROMOSOME-MARKED BONE MARROW AND SUBJECTED TO ANTIGENIC STIMULATION. Ford, C. E.; Micklem, H. S.; Evans, E. P.; Gray, J. G.; Ogden, D. A. (Medical Research Council, Harwell, Eng.). Ann. N. Y. Acad. Sci., 129: 283-96(Dec. 30, 1966).

CBA mice were given 1000 rad of x-rays to approximately the lower third of the body and injected with 10^7 CBA-T6T6 bone marrow cells. They were killed at intervals for cytological examination of the dividing cells in myeloid and lymphoid tissues. Donor cells (identified by T6 marker chromosomes) promptly and permanently recolonized the irradiated portion of the recipients' bone marrow which, however, also contained a substantial minority of host cells which had presumably migrated in from the shielded part of the body. Very few donor cells were found dividing in the thymus during the first week after irradiation, but the proportion gradually increased with time before reaching a plateau after about 3 months. An increase with time was also seen in the lymph nodes. Mice grafted with rat skin 1 or 2 months after irradiation and 2–4 weeks before sacrifice had a significantly higher proportion of donor cells in both thymus and lymph nodes than did nongrafted controls. This suggested that the cellular response to the xenograft might be causing an outflow of thymic lymphocytes into peripheral lymphoid tissue, and having thus depleted thymic reserves, be accelerating the recruitment of stem cells from the bone marrow. However, there is an element of doubt in this interpretation since, under the conditions of the experiments, neither BSA in Freund's Adjuvant nor pertussis vaccine was shown to have a similar effect, and only two animals showed any significant sequel of allografting. The proportions of donor cells in the femurs and humeri remained virtually constant over periods of up to two years and showed no tendency to reach equilibrium. This indicates that hematopoietic stem cells, although they certainly circulate normally in the blood, do not under normal conditions settle out and proliferate in the bone marrow. (auth)

20343 EFFECT OF TOTAL BODY IRRADIATION ON TRANSPLANTATION IMMUNITY. Najarian, John S.; Jolicoeur, Dianne M. (Univ. of California, San Francisco). Ann. N. Y. Acad. Sci., 129: 714-23(Dec. 30, 1966).

The primary effect of total body irradiation on transplantation immunity was to increase the amount of space available for transfused cells in nonsensitized animals. After irradiation, the lymphoid space available for isologous or homologous cells doubled. When low doses of irradiation (50 to 400 R) were used, the elimination of homologous transferred cells increased as a result of intensified reticuloendothelial cell activity and possibly a stimulation of the immune response. The only abrogation of the immune response occurred in presensitized mice that behaved as nonsensitized animals after receiving doses of irradiation greater than 750 R. The loss of transplantation immunity in these experiments may have resulted from the decreased radioresistance of sensitized cells as compared to nonsensitized cells. A more logical explanation, however, is that the sensitized animals had a greater number of immunologically committed cells, which were greatly reduced by total body irradiation. (auth)

20344 INFLUENCE OF INCUBATION CONDITIONS ON THE RADIOBIOLOGICAL EFFECTS ON EGGS OF BOMBYX SILK WORMS. Akhalaya, Ya. G. Soobshch. Akad. Nauk Gruz. SSR, 44: 727-34(Dec. 1966). (In Georgian).

X-irradiation to 1500 R produced a negative effect on embryonic development of bombys (sericaria mori) silk worm eggs. However, the damaging effects were eliminated by changing the incubation conditions which precluded winter laying. The influence of various incubation conditions on radiobiological effects on silk worm eggs is of practical importance. (R.V.J.)

20345 RADIOSENSITIVITY AND THE COURSE OF RADIATION SICKNESS IN VARIOUS RODENT SPECIES IRRADIATED WITH LD 50/30 AND LD 100/30 DOSES. Bregadze, M. A. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 44: 749-56(Dec. 1966). (In Russian).

Experimental studies were made with 170 white mice, 30 guinea pigs, and 30 rabbits of the same age, sex, and weight x-irradiated with 600, 800, 1000, and 1500 R; 400, 616, and 728 R; and, 850, 1050, and 1400 R, respectively. The results revealed that with the dose increase from $LD_{50/30}$ to $LD_{100/30}$ the life span of the animals was reduced and death rate increased. The rate of weight loss in identical species with different initial weights was identical. Increased $LD_{50/30}$ doses rapidly reduced the number of leukocytes in all rodents (about 2 to 4% in 1 ml of blood) the changes in the numbers of erythrocytes and leukocytes at the beginning of the sickness were identical in all rodents. The difference was observed during the peak of radiation sickness (in mice on 14th day, in guineas on 8th and 10th day, and in rabbits on the 15th day). Hemorrhagic syndrome, induced by $LD_{100/30}$, was more pronounced in guinea pigs than in mice or rabbits. (R.V.J.)

20346 LASER RADIATION: ACUTE EFFECTS ON CEREBRAL CORTEX. Brown, Thomas E.; True, Charles; McLaurin, Robert L.; Hornby, Peter; Rockwell, R. James (Children's Hospital Research Foundation, Cincinnati). Neurology, 16: 730-7(Aug. 1966).

Effects of focused ruby laser beams (energy levels, 5–40J) on the cerebral cortex of dogs were determined. Crater formation measuring 1 min in depth and rupture of the overlying pial membrane occurred at the site of impact with an energy level of 40 J. Hemorrhage was observed in the charred area of punctate lesions, as well as on the margins of the subpial and subarachnoid membranes. Microscopic observations revealed that the core of rarefied neurophil was distinctly separate from normal brain tissue; in the center of lesions, eosinophilic homogenation of the cytoplasm of neurons had occurred; acute swelling of oligodendrocytes was present around areas of coagulation necrosis; on the walls of leptominingeal vessels, pyknotic endothelial nuclei and emigrated polymorphonuclear leucocytes were present; and that at the margin of lesions, capillaries were dilated or ruptured. Laser effects on the cellular elements of the cerebral cortex were not uniform; neurons were very susceptible to laser energy whereas astrocytes proved to be more resistant. However, the local vascular bed was severely damaged by the laser beam, and the apparent difference in cell susceptibility to laser energy was thought to be secondary to the effect of local anoxia that was caused by vascular injury. As an explanation for possible mechanisms of the effect of laser radiation on tissues, consideration was given to thermal injury, as determined by histopathological criteria and to local anoxia. (TSS)

20347 BIOCHEMICAL INDICATORS OF RADIATION DAMAGE. I. CHANGES IN PLASMA β-AMINOISOBUTYRIC ACID IN RAT AFTER IRRADIATION. Smith, H.; Wallas, J.; Sturrock, M. (United Kingdom Atomic Energy Authority, Annan, Eng.). Int. J. Radiat. Biol., 11: 383-4(1966).

Rats were intraperitoneally injected with β-aminoisobutyric acid (BAIBA) 24 hr after 650 R x irradiation. A significant increase in the plasma BAIBA concentration occurred. This is thought to be a reflection of metabolic impairment. (C.O.)

20348 PRODUCTION OF MELANOMAS FROM DMBA-INDUCED "BLUE NEVI" IN HAIRLESS MICE WITH ULTRAVIOLET LIGHT. Epstein, J. H.; Epstein, W. L.; Nakai, T. (Univ. of California, San Francisco. Chicago Medical School). J. Nat. Cancer Inst., 38: 19-30(Jan. 1967).

The effects of chronic low-dose mid-ultraviolet (UVL) exposures on benign blue nevi were examined in pigmented hairless mice. The benign growths were produced by a single application of 7,12-dimethylbenz[a]anthracene (DMBA). In this study, large invasive melanocytic tumors were produced by the UVL in 5 of 18 animals. Apparent seeding of regional lymph nodes with tumor cells was a consistent feature of the melanomas. No distant metastasis was noted. No similar growths occurred spontaneously or in control groups receiving DMBA or UVL alone. Histologic, electron microscopic, and autoradiographic studies established that the tumor was composed of functioning neoplastic melanocytic cells. It was suggested that the system could serve as a model for evaluation of factors influencing melanoma formation. (auth)

20349 MORPHOLOGICAL CHANGES OF THE LIVER IN ANIMALS INJECTED WITH RADIOACTIVE STRONTIUM. Lebedeva, G. A. Byull. Eksp. Biol. Med., 63: No. 2, 118-21(Feb. 1967). (In Russian).

In dogs and rats injected with ^{90}Sr the most pronounced morphologic changes of the liver tissue were observed long after the injection. These changes were generally localized in the centers of liver lobules and were identified as a dystrophic process, sometimes accompanied by atrophic, necrotic and sclerotic changes. The experimental data showed that within the dose range used the

depth of the tissue injury was determined by the outcome of radiation disease and not by the dose. The results of the morphological study and the calculations of the liver tissue dose suggest that the effect of ^{90}Sr on the liver is mainly an indirect one. (auth)

20350 INFLUENCE OF BCG VACCINE ON THE RESULTS OF GAMMA-RADIATION WITH ^{60}Co OF RATS. Moskalev, Yu. I.; Klemparskaya, N. N.; Petrovich, I. K. Byull. Eksp. Biol. Med., 63: No. 2, 35-7(Feb. 1967). (In Russian).

The influence of BCG vaccination is reported on the composition of blood, duration of life, and frequency of tumors of the breast in rats irradiated with gamma rays (^{60}Co) in a dose of 300 R. Administration of the vaccine provokes transient neutrophil leucocytosis, without affecting the life span. Administration of BCG vaccine 2 weeks prior to irradiation decreases the frequency of breast tumors. (auth)

20351 LIFETIME ACTIVITY STUDIES IN MICE FROM TEN TO THIRTY GENERATIONS OF X-IRRADIATED PROGENITORS. Spalding, J. F. (Los Alamos Scientific Lab., N. Mex.). Proc. Soc. Exp. Biol. Med., 124: 833-6(Mar. 1967). (LA-DC-8372).

Lifetime voluntary activity studies on non-irradiated mice from 10 to 30 generations of x-irradiated progenitor males were done. Mice from irradiated lines were equally active to nonirradiated line mice. It was apparent from the results of these investigations that 30 generations (the equivalent of 900 years in man) of x irradiation totaling 6000 rads failed to produce a genetic decrement measurable in terms of reduced vigor. (auth)

20352 PREVENTION OF SV_{40} VIRUS TUMORIGENESIS BY IRRADIATED, DISRUPTED, AND IODODEOXYURIDINE TREATED TUMOR CELL ANTIGENS. Coggin, J. H.; Larson, V. M.; Hilleman, M. R. (Merck Inst. for Therapeutic Research, West Point, Pa.). Proc. Soc. Exp. Biol. Med., 124: 774-84(Mar. 1967).

Hamster SV_{40} tumor cells rendered nonproliferative by exposure to γ rays or by propagation in the presence of iododeoxyuridine were highly effective when used as immunizing antigens for preventing the appearance of tumors in hamsters that had received SV_{40} virus when newborn. Only a single injection of immunizing antigen was employed. Disruption of tumor cell preparations by freeze-thaw or by treatment in a French pressure cell for purpose of fractionation resulted in total or near total loss of immunizing capability, even when incorporated into alum adjuvant. Possible mechanisms for loss of potency are discussed. (auth)

20353 THE RESPONSE OF THE GILL EPITHELIUM OF THE ADULT AXOLOTL (SIREDON MEXICANUM) TO ROENTGEN RADIATION. Brunst, V. V. (Roswell Park Memorial Inst., Buffalo). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 99: 482-98(Feb. 1967).

The right gills of adult axolotls (Siredon mexicanum), 5 to 6 years old, were locally irradiated with 2,000 R in 10 animals, 4,000 R in 10, and 8,000 R in 10; 10 animals served as untreated controls. Disappearance of the gill filaments is possible in the course of normal development, especially in old axolotls, but was the rule after irradiation. In the present study, normal filaments were never seen after irradiation. The gill filament and the gill epithelium are very sensitive to roentgen radiation, much more so than the skin epithelium. The gill epithelium is one of the most sensitive types of epithelium in the adult axolotl. Even as little as 2,000 R, the smallest dose used, completely disorganized and destroyed the gill filaments and the gill epithelium, which were later replaced with skin epithelium containing many Leydig cells. After irradiation with 8,000 R, giant cells developed in the skin epithelium that replaced the destroyed gill epithelium. Such giant cells were probably caused by moderate radiation damage to the peripheral skin epithelium. Mitosis is extremely rare in the adult axolotl, but it was usually frequent in close proximity to epithelial cells damaged by irradiation with 8,000 R. Evidently, this observation is an example of radiation stimulation. In the lower vertebrates, the particularly the axolotl, radiation stimulation has previously been observed almost exclusively in young animals; mitosis has never before been observed as a result of radiation stimulation in adult axolotls. The stimulation mitosis activity following irradiation of the gills of adult axolotls in the present study is thus the first case of its kind. A survey of the literature shows that sensitivity and response to radiation differ widely between different types of epithelium, especially skin epithelium and the epithelium of the internal organs, and may even differ widely for a single type of epithelium in young and adult animals. (auth)

20354 RADIATION INDUCED HEPATIC INJURY. ITS DETECTION BY SCINTILLATION SCANNING. Johnson, Philip M.; Grossman, Frederick M.; Atkins, Harold L. (Columbia Univ., New York). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 99: 453-62(Feb. 1967).

Radiation induced suppression of hepatic reticuloendothelial function was demonstrated by scintillation scanning in 6 patients undergoing therapeutic irradiation of the liver. In the 1 patient so tested, suppressed hepatocellular function was also demonstrated. Evidence of injury to the liver was the de novo appearance of a well defined area of diminished or absent radioactivity on the scintillation scan, corresponding to the position of the radiation portals in each case. In 3 patients, reappearance of normal function was observed 84-106 days post irradiation. Follow-up of the remaining patients was limited to shorter periods. There were no clinical findings attributable to radiation induced hepatic injury. These data are additional evidence that the liver is a relatively radiosensitive organ. (auth)

20355 COLLOIDAL THORIUM DIOXIDE (THOROTRAST) IN RADIOLOGY WITH EMPHASIS ON HEPATIC CANCEROGENESIS. A CASE REPORT OF OCCLUDED CAROTID AND JUGULAR VESSELS WITH NERVE INJURIES AND A CASE OF HEPATOMA, 27 AND 33 YEARS AFTER ITS ADMINISTRATION. Kuisk, Hans; Sanchez, Jose S.; Mizuno, Nobuko S. (Univ. of Minnesota, Minneapolis). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 99: 463-75(Feb. 1967).

The history, dosage, roentgenographic diagnosis, sequelae, and the present day use of this colloidal form of thorium dioxide are reviewed. Two cases of severe thorotrast reaction are reported. In I, a 60 year old male, extravasation of thorotrast had occurred into the carotid sheath 27 years previously at attempted carotid arteriography which resulted in obliteration of the right common carotid artery and internal jugular vein. The second case a 53 year old male, developed a liver cell type of carcinoma (hepatoma) 33 years after the intravenous administration of thorotrast. Another factor in liver carcinogenesis was present in Case II; namely, chronic alcoholism. The high relationship of liver cell carcinomas with Laennec's cirrhosis is well accepted. However, one cannot state with certainty that in this case, the chronic use of alcohol added any additional cirrhotic changes to the already present severe cirrhosis due to alpha rays. The principal carcinogenic effect in this case is considered to be the extremely high absorbed dose of radiation; namely, 34,000 rems to the liver from the alpha particles. In Case I, the severe granulomatous desmoplastic reaction from this long term alpha emitter did cause a complete obliteration of the right common carotid artery and of the internal jugular vein. There was also an associated right sided vocal cord paralysis, Horner's syndrome, and paresis of the ninth to twelfth cranial nerves. (C.O.)

20356 THE EFFECTS OF IRRADIATION (EXTERNAL AND INTERNAL) ON LYMPHATIC DYNAMICS. Ariel, Irving M.; Resnick, Michael I.; Oropeza, Ruben (New York Medical Coll. Pack Medical Foundation, Inc., New York). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 99: 404-14(Feb. 1967).

Of the 10 patients on whom lymphographic studies were made after the administration of external radiation therapy, none manifested abnormality or compromise in lymphatic dynamics. Of the 20 patients on whom lymphographic studies were made after the endolymphatic administration of radioactive isotopes very little, if any, effect was observed upon the lymphatic vessels and the dynamics of lymph flow; however, a marked effect upon the lymph nodes occurred. Whereas the lymph nodes are radiosensitive and can be destroyed with the usual doses of external and internal irradiation given in clinical practice, the lymphatic vessels are radioresistant and orthodox dosages exert no observed effect upon them as noted in this study. Attention is directed to the fact that the lymphatic vessels should be considered separately from the lymph nodes in that they are different organs structurally and functionally. The free transport of administered ethiodol through irradiated regions was observed. No new collateral lymphatic vessels were seen and no obstructive phenomena in the lymphatic system occurred. Accordingly, the concept whereby irradiation would seal off the lymphatic vessels appears to be incorrect. A comparison is made of the effect of surgical extirpation of certain groups of lymph nodes (lymph nodes in the groin and axilla) with the effect of irradiation of these lymph nodes. The alterations in lymphatic dynamics which occur after surgery are profound, and demonstrate that if clinically indicated, a radical excision of the lymph nodes should be performed in continuity with the primary cancer. If an in-continuity operation cannot be performed and if one is dealing with a radiosensitive malignant neoplasm, irradiation might be the preferred treatment in that it does not significantly alter the lymphatic dynamics. No significant change in lymphatic vessel structure and function was observed either from irradiation delivered from an external source, or from that administered internally in the form of the endolymphatic injection of radioactive isotopes (^{131}I ethiodol, ^{198}Au and ^{90}Y micromicrospheres). The clinical implications of the foregoing observations are discussed. (auth)

20357 DETECTION OF MITOTIC CHROMOSOMES AND LAMPBRUSH CHROMOSOMES INDUCED BY THE IRRADIATION

OF EGGS OF THE AMPHIBIAN URODELE PLEURODELES WALTLII MICHAH. Gallien, Louis; Labrousse, Monique; Lacroix, Jean-Claude (Faculte des Sciences, Paris). Compt. Rend., Ser. D, 263: 1984-7(Dec. 19, 1966). (In French).

Eggs of the amphybian, Urodele pleurodeles, were exposed to 70 R of γ radiation and chromosomes of embryos, larvae, adults, and of various tissues were analyzed for aberrations. Caryotyse analysis of chromosomes revealed both reciprocal translocation and deletion. Chromosome aberrations observed in larvae were also observed in adults, indicating that the same aberration was maintained during the course of development. (C.H.)

20358 DELAYED RESPONSE OF THE HEMOPOIETIC TISSUE TO THE PROTONS AND X IRRADIATION COMBINED WITH ACCELERATION. Zharova, E. I.; Khrustalev, S. A.; Protasova, T. G.; Davydov, B. I.; Antipov, V. V.; Saksonov, P. P.; Raushenbakh, M. O. Izv. Akad. Nauk SSSR, Ser. Biol., No. 2, 290-6(Mar.-Apr. 1967). (In Russian).

Mice were exposed to 660 MeV protons, x radiation, acceleration, or various combinations of irradiation and acceleration and six months later the bone marrow, peripheral blood, and spleen were examined. The results indicated a delayed pathological response of the hematopoietic system to the combined effects of irradiation and acceleration. Implications of the findings for astronauts exposed to the combined effects of radiation and acceleration during space flights are discussed briefly. (R.V.J.)

20359 HYPOTHYROIDISM AFTER EXTERNAL IRRADIATION TO THE THYROID REGION. Einhorn, Jerzy; Wikholm, Gunnel (Radiumhemmet, Stockholm). Radiology, 88: 326-8(Feb. 1967).

Forty-one patients out of a series of 63 who received external irradiation for laryngeal or hypopharyngeal carcinoma were examined more than ten years after therapy. In 3 there were clinical signs of hypothyroidism, which improved on thyroid medication. The remaining 38 showed a significant decrease in the thyroid response to administered thyrotropin, as measured by the increase in the uptake of radioiodine by the thyroid gland. It is concluded that the "thyroid reserve" is diminished and hypothyroidism not uncommon many years after heavy external irradiation to the neck. (auth)

20360 ANALYSIS OF THE MORBIDITY AND MORTALITY OF CHILDREN IRRADIATED IN FETAL LIFE. Griem, M. L.; Meier, Paul; Dobben, Glen D. (Univ. of Chicago). Radiology, 88: 347-9(Feb. 1967).

In a study involving 3,024 children, 1,008 of whom received an x-ray exposure dose of between 1.5 and 3 rads in utero, a number of illnesses were investigated. A significant increase in frequency of hemangiomas was found in the children exposed to radiations in utero, but no significant increase in anomalies of the eye was observed. (auth)

20361 RADIATION SENSITIVITY IN DIABETES: PRELIMINARY STUDIES WITH THE ALLOXAN DIABETIC RAT. Gunn, Walter G.; Slager, Ursula; Koukol, Dennis C. (Univ. of California, Los Angeles). Radiology, 88: 349-52(Feb. 1967).

Histologic skin lesions developed in diabetic rats, as well as in nondiabetic controls at doses of 6,000 to 7,000 R in six weeks, when this x radiation was delivered in fractions of 400 R two and three times weekly. Such lesions are much more severe in the diabetic than in nondiabetic animals but do not develop at lower dose levels in the diabetic animal. Future work will be directed toward elucidating the significance of the fibrinoid necrosis of nerves and frank hemorrhages seen in this group of diabetic irradiated animals and will also include exposures of larger numbers of animals to doses in excess of the maximum 7,000 R administered here, as well as lengthening the interval between diabetes induction and irradiation. In conclusion, the above results suggest a much more severe skin response in the diabetic rat as compared to the nondiabetic control at similar radiation exposures. (auth)

20362 INFLUENCE OF X-RAYS ON THE DEVELOPMENT OF EMBRYOS AND PLACENTA OF RATS AFTER IRRADIATION ON THE 9TH DAY OF PREGNANCY. Nikonov, A. P. (Grodno Medical Inst., USSR). Byull. Eksp. Biol. Med., 63: 85-8(Jan. 1967). (In Russian).

Rats were irradiated on the 9th day of pregnancy with an x ray dose of 200 R. Irradiated females, with slight signs of radiation sickness, show subsequently disorders of embryogenesis, manifested by increase in the number of pathologically modified embryonic sac with hemorrhages into the uterine wall and into the vitelline sac, by considerable decrease of dimensions and weight of the embryonic sac which affects the length of embryos. All the above changes manifest themselves six days after irradiation which speaks in favor of the existence of a latent period in the development of pathological changes of the foetus and of the placenta. (auth)

20363 AN INVESTIGATION OF THE EFFECT OF X-RAYS ON THE RATE OF DNA-SYNTHESIS IN MOUSE L-CELLS. Holford, R. M. (Cambridge Univ., Eng.). Int. J. Radiat. Biol., 11: 367-71(1966).

Mouse L-strain cells were grown in tissue culture on glass coverslips and part of each culture was exposed to x radiation. Tritiated thymidine was administered and the cultures were then fixed and Feulgen stained. The DNA content of individual cells was estimated by microspectrophotometry, and the rate of DNA-synthesis was estimated autoradiographically. The results show an increased sensitivity of DNA-synthesis to a moderate dose of x radiation in cells nearing the end of the DNA-synthetic period, but this difference in sensitivity is not maintained if a larger dose of radiation is used. (auth)

20364 γM AND γG ANTIBODIES IN MICE: DISSOCIATION OF THE NORMAL IMMUNOGLOBULIN SEQUENCE. Blinkoff, Richard C. (Harvard Medical School, Boston). J. Immunol., 95: 736-46(1966).

Experiments dealing with the transfer of γM and γG antibody production to homologous x-irradiated recipients were used to study the importance of anatomical relations and extracellular antigen to the normal immunoglobulin sequence. Mice were given a 650 R dose of x rays 24 hr prior to receiving injections of primed spleen cells. When spleen cells were taken from immunized donors on day 2 or day 6 after injection of antigen, only γM antibody could be demonstrated in the irradiated recipients. Spleen cells taken on day 8 or day 10 after antigen produced mostly γG antibody in the recipients. Amethopterin and colchicine administered during a primary response to Salmonella adelaide in mice both preferentially inhibited γG antibody formation. The γM and γG antibody responses seemed to be independent of one another. The γM antibody response was not prolonged by the immediate absence of a following γG response. Also, the γG antibody response was able to recover from the effects of both drugs and reach near-normal serum titers whether or not there was a preceding γM response. During a methotrexate-inhibited response, normal levels of γM occurred in serum when no pyroninophilic blast cells or secondary nodules were evident in the spleen. The recovery of γG production was correlated with the appearance of many hemocytoblasts in the splenic red pulp, although no secondary nodules or mature plasma cells could be found at this time. (BBB)

20365 CONTINUOUS IRRADIATION OF A MURINE LYMPHOMA LINE P388F IN VITRO. Fox, Margaret; Gilbert, C. W. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol., 11: 339-47(1966).

The response of the P388F murine lymphoma in vitro to continuous irradiation at dose-rates between 60 and 210 rad/day from tritiated water in the culture medium has been studied. The population doubling time of the cultures increases with increasing dose-rate. Labeling experiments with ^{3}H thymidine indicated some increase in cell-cycle time and also the existence of non-dividing cells. Cloning techniques demonstrated that not all cells capable of synthesizing DNA have the capacity for indefinite reproduction. A model which accounts for the results is discussed. It proposes that, as a result of the continuous irradiation, at each cell division a proportion of the daughter cells lose their reproductive integrity but may nevertheless undergo several divisions before becoming completely sterile. (auth)

20366 LOSS OF PRE-IRRADIATION IMMUNITY TO HYMENOLEPIS NANA IN THE RAT–MOUSE CHIMERA. Neas, Barbara R. (Civil Aeromedical Inst., Oklahoma City); Friedberg, Wallace; Self, J. Teague. Int. J. Radiat. Biol., 11: 349-56(1966).

Mice were immunized by infection with Hymenolepis nana eggs. Intestinal tapeworms developed and were eventually expelled. The mice were then x-irradiated (950 R) and injected with 40 million syngeneic bone-marrow cells from non-immune mice or with 140 million rat bone-marrow cells. At different times after irradiation and treatment with bone-marrow, groups of mice were given a challenge dose of parasite eggs to test for persistence of immunity. Comparisons between groups were based on the number of worms that developed after the egg-challenge. The mice treated with syngeneic bone-marrow and the rat–mouse chimeras both resisted reinfection when challenged one day after irradiation. Two and three weeks after irradiation, the degree of infection after egg-challenge was greater in the rat–mouse chimeras than in the mice treated with syngeneic marrow. These results indicate that persistence of immunity acquired before irradiation is influenced by the type of bone-marrow implanted after irradiation. (auth)

20367 OXYGEN TENSION IN MOUSE MUSCLE TISSUE AFTER X-RAY IRRADIATION WITH LETHAL DOSES. Davidova, Eva (Inst. of Biophysics, Brno). Int. J. Radiat. Biol., 11: 403-6(1966).

Oxygen tension, as measured by an electrode inserted in leg muscular tissue, significantly decreased after exposure to 1025 R.

Narcotization did not seem to affect the post-irradiation changes. After exposure to 850 R a significant decrease also occurred, but a little later. A steeper tissue oxygen tension decrease occurred in experiments with inhalation of pure oxygen. This indicates that the organism gradually loses the ability to compensate tissue hypoxia during an increased supply of oxygen. (C.O.)

20368 REGENERATION TIME IN IRRADIATED HYDRAS. Mookerjee, Sivatosh; Aditya, Ajit (Presidency Coll., Calcutta). Indian J. Exp. Biol., 4: 201-5(Oct, 1966).

The rate of regeneration of hypostome and basal disc removed singly or together at different intervals from hydras subjected to varying doses of x radiation has been studied. Hypostome regeneration of hydra amputated on the same day of irradiation takes less time than the controls, whereas the regeneration of basal disc takes longer. From the second day onwards the regeneration of lost parts takes a longer time than the controls. Hypostome regeneration is inhibited in hydras irradiated with doses of x radiation ranging from 20000 to 50000 rads; at lower doses there is no inhibition. Histological studies on the nonregenerating hydras show that the effect of radiation appears to be primarily one of differentiation. X-irradiation stimulates hypostome formation in the beginning and inhibits the formation of basal disc. The initial stimulating effect of hypostome regeneration is normalized with the passage of time or it is ultimately inhibited depending upon the radiation dose. Hypostome formation is progressively inhibited at high doses of x-irradiation. (auth)

20369 SOME EFFECTS OF MACROFRACTIONATED GAMMA RAY IRRADIATION UPON THE RHESUS PRIMATE. Melville, George S. Jr.; Harrison, George W. Jr.; McDowell, Arnold A.; Wright, James F.; Brown, W. Lynn; Hekhuis, Gerrit L. (Univ. of Texas, Austin). Contract 41(609)-2005. Aerospace Med., 38: 256-67(Mar. 1967).

This study explores the effect of graded doses of gamma radiation delivered at intervals postulated to allow recovery from transient effects. Accumulated doses of 200 R up to 1000 R were delivered to 36 Macaca mulatta monkeys during a period estimated to be ten "monkey years" (1200 days). No changes due to chronic radiation were noted for hematology but a challenge dose of radiation to two of the lowest radiation dose groups near the end of the schedule caused a depression in total white blood cells and platelets. The principal early effect of the chronic radiation exposure was observed for behavioral measures. Chronic gastrointestinal disturbances were manifested about one year post-exposure, especially in the higher dose groups. Pathologic examination shows radiation-induced damage in the high dose animals that died. Observations of differences between the sexes were made both behaviorally and hematologically, but none of these could be attributed to the radiation exposure. (auth))

20370 MICROWAVE RADIATION AND ITS EFFECT ON RESPONSE TO X-RADIATION. Thomson, R. A. E.; Michaelson, Sol M.; Howland, Joe W. (Univ. of Rochester, N. Y.). Contracts AF30(602)-224; W-7401-eng-49. Aerospace Med., 38: 252-5(Mar. 1967).

Dogs were exposed to simultaneous microwave (2800 Mcycles/sec, 100 mW/cm^2) and x ray (250 KVP, 1656 R, 4.6 R/min) exposure, or to the same x ray exposure nine months after a total of 90 hours of multiple microwave exposure. Mortality was greater in animals treated with microwaves, and was most marked following simultaneous microwave and x irradiation. Deaths were hemopoietic in nature. Survival appeared best in dogs showing minimal leukocyte and neutrophil changes immediately after x irradiation. Hematocrit, erythrocyte sedimentation rate, reticulocyte, rectal temperature, body weight, food and water consumption changes are presented. Microwave treatment can modify the response to x irradiation, and its effect appears related to the total microwave exposure, duration of microwave exposure, rectal temperature response, time interval before x irradiation, total x irradiation and x ray dose rate. Modification of ionizing radiation injury at the hematopoietic level is indicated. (auth)

20371 CHEMICAL SENSITIZATION OF MICE TO RADIATION LETHALITY. Moroson, Harold; Spielman, Howard A. (Sloan-Kettering Inst., New York). Int. J. Radiat. Biol., 11: 87-98(1966).

Thiol binding reagents such as N-ethyl maleimide, iodoacetamide, and chloromercuribenzoate are known to potentiate or sensitize the radiation inactivation of bacteria. These agents have been tested for their ability to sensitize mice when injected intraperitoneally immediately before whole-body γ irradiation. The results have shown that mice given a threshold lethal dose of 525 rad after injection with thiol-binding agents exhibit 30-60 per cent greater mortality than the controls. The sensitizing effect is believed not to be due to drug toxicity, and decreases with increasing dose of radiation. At the higher radiation dose of 810 rad, 50 per cent mortality occurs in 4-6 days, which suggests gastrointestinal rather than bone-marrow damage as the cause of death. Other chemical agents known to radiosensitize bacteria have been tested in mice: thioglycolic acid and 5-bromouracil were not effective but methyl hydrazine was a potent radiosensitizer. (auth)

20372 THE EFFECT OF 2000 R OF X-RAYS ON THE INTERNAL STRUCTURE OF THE MOUSE TIBIA. Sams, Alice (Westminster Hospital, London). Int. J. Radiat. Biol., 11: 51-68(1966).

The effects of 2000 R of x-rays on the structure of the epiphyseal plate of the tibiae of 3 weeks and 12 weeks old mice are described. The initial effects were the disorganization of the epiphyseal plate due to the death of actively dividing cells and the cessation of cell erosion at the metaphyseal edge of the plate and of endochondral ossification, resulting in the formation of a wide plate with a low cell: matrix ratio, and diminished glycogen content. The resorption of bone in the metaphysis continued. This irradiated plate did not always persist and in some animals, clusters of cartilage cells appeared after about 9 weeks and initiated a new plate, the old one being split off and resorbed. It is considered that the formation of a new plate was dependent on the survival of stem cells with an intact reproductive mechanism and the maintenance of an adequate metaphyseal circulation. Where the blood supply was seriously reduced degenerative changes appeared in the bone marrow, cartilage and bone matrix and eventually culminated in necrosis of the lower part of the limb. (auth)

20373 KINETICS OF RECOVERY DURING THE FIRST FEW WEEKS AFTER WHOLE-BODY X-IRRADIATION OF MICE. Corp, M. J.; Mole, R. H. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 11: 69-86(1966).

Residual damage after five different exposures to whole-body radiation has been titrated at frequent time-intervals between 6 hours and 6-7 weeks by determination the additional dose which results in 50 per cent deaths in 30 days. The results fit very well a three-phase model for recovery based on known biological and radiobiological properties. During the first few hours recovery is rapid and independent of dose size. The second phase proceeds from about 6 hours on at a constant rate of about 50 rad per day. The constancy of the rate is due to the logarithmic nature of cell division in the irradiated host and the value of the daily rate depends on D_{37} and cell doubling time. The duration of the second phase is dose-dependent. In the third phase the level of recovery oscillates above and below a mean because of the inertia of the system which regulates cell number in the haematopoietic tissue of the complex organism. The pattern of oscillation is independent of dose size. The incompleteness of recovery after the larger priming doses and the dependence of the oscillatory pattern on the duration of the priming dose are not explained by the model. The kinetics of recovery cannot be accounted for by a single exponential hypothesis. (auth)

20374 COMPARISON OF X-RAY SURVIVAL CURVES OBTAINED FROM CELLS CULTURED IN VITRO WITH THOSE OF THE PARENT STRAIN ASSAYED IN VIVO. Cullen, Beulah; Hornsey, Shirley (Medical Research Council, London). Int. J. Radiat. Biol., 11: 35-41(1966).

The survival of a strain of mouse ascites tumor cells after x-irradiation has been previously using an in vivo technique in which surviving cells were assayed in very young mice. Since then the same strain of cells has been cultured in vitro for 2 years and during this time survival of the cells after x irradiation has been measured by an in vitro method. The results obtained by the two different methods were in close agreement which suggests that the in vivo results were not complicated by an antigenic response from the young mice and that after irradiation these cells behave in a similar manner whether they are grown in vitro or in vivo. (auth)

20375 LYMPHOBLASTOID TRANSFORMATION OF LYMPHOCYTES IN VITRO AFTER MICROWAVE IRRADIATION. Stodolnik-Baranska, W. (Univ. of Warsaw). Nature, 214: 102-3(Apr. 1, 1967).

It is known that lymphocytes grown with various added substances in vitro can transform into cells resembling blastoid forms or macrophages. It was found that this type of transformation can be induced by microwave irradiation. Studies are described employing human lymphocytes, with 10 cm. microwaves. Percentages of transformed lymphocytes in irradiated and control cultures are tabulated. Results were not attributable to heating effects. After incubation for 3 days cultures irradiated at a power density of 7 m W/cm^2 showed twice as high percentage of transformation as controls. Changes were more distinct at higher power densities (five times as high as controls). The percentage of macrophages was also high, and there were 2 to 3% of mitoses. Fragmented nuclei could be seen among the transformed cells. (auth)

20376 ANIMAL EXPERIMENTAL STUDIES ON RADIATION PNEUMONITIS. Lissner, Josef; Argenton, Hans; Bock, Heinrich; Breddin, Hans-Klaus; Dippell, Juergen (Univ., Frankfurt am Main). Strahlentherapie, 131: 577-94(Dec. 1966). (In German).

Animal experiments were done to investigate the roentgenological, pathohistological, and humoral changes during the course of radiation pneumonitis. The appearance of pneumonitis is accompanied by a decrease in the total complement as well as an increased agglutination tendency of the thrombocytes. A model for the genesis of the radiation pneumonitis is proposed and the possibility of accompanying immunopathological events is pointed out. (auth)

20377 EARLY CHANGES IN THE ULTRASTRUCTURE OF THE CEREBELLUM OF GUINEA PIGS FOLLOWING ^{60}Co IRRADIATION OF THE HEAD. Lierse, Werner; Franke, Herbert D. (Univ., Hamburg). Strahlentherapie, 131: 595-602(Dec. 1966). (In German).

Early changes in the cerebellum of guinea pigs observed 24 hours after telecobalt irradiation with 1,000, 2,000, and 3,000 R are reported. In the ultrastructural range, swelling of the medulla-poor nerve cell continuations and a hydrops of the astrocytic glia and destruction of the medulla-layer are observed; their structures are described in detail. Capillary changes are uncommon. (auth)

20378 EFFECT OF GAMMA IRRADIATION (^{60}Co) ON THE FORMATION PROLIFERATION AND DIFFERENTIATION OF PRIMITIVE HEMATOPOIETIC CELLS OF CHICK EMBRYOS. Knezevic, Zoran; Karanovic, Jovo. Bull. Boris Kidrich Inst. Nucl. Sci., 17: 219-26(July 1966).

The effect of irradiation (600 R) of chick embryos in the blastula stage on the formation, mitotic activity and differentiation of primitive hematopoietic cells was investigated. Results show that in subsequent cytogenesis the mitotic activity is reduced on the 2nd, 3rd, and 4th day of incubation, at the stage of promegaloblasts and basophilic megaloblasts, while the maturation of primitive hematopoietic elements, estimated on a hematogram, is negligible. (auth)

20379 EFFECT OF FRACTIONATED IRRADIATION ON CHANGES IN THE BONE MARROW OF RATS. Ninkov, Vukosava; Karanovic, Jovo; Dragic, Marko; Hajdukovic, Srdjan. Bull. Boris Kidrich Inst. Nucl. Sci., 17: 227-33(July 1966).

The effect of fractionated gamma irradiation (3 × 200 R, 10-day intervals) on the proliferative activity of bone marrow cells in rats has been investigated. Results have shown that each fraction of radiation considerably reduces the proliferative activity of erythroid and myeloid marrow cells, and the preceding fractions do not affect the reduction after each radiation. It was also found that after a single irradiation of 600 R there is no proliferative activity in the bone marrow. Regeneration of the proliferative activity occurs rather quickly, viz. on the third day after each fraction of radiation, but after the third fraction its value is considerably higher than normal. In the same postirradiation period there is still no regeneration after single irradiation with 600 R. The myeloid to erythroid marrow cell ratio showed corresponding correlation with the behavior of the proliferative activity. (auth)

20380 IDIOPATHIC MYELOFIBROSIS WITH TERMINAL EFFUSION OF RETICULAR CELLS IN THE PERIPHERAL BLOOD. THE PRESENCE OF PHAGOCYTOSED THOROTRAST IN THE HISTOLOGICAL EXAMINATION OF ORGANS. Jedlicka, Vladimir; Hermanska, Zorka; Kubat, K. (Karlovy Univ., Prague). Acta Med. Scand., 169: 479-93(1961). (In German).

The case history of a 75-yr-old woman who had been injected with Thorotrast 22 yr previously is given in detail. Thorotrast had been injected to investigate splenomegaly. An idiopathic myelofibrosis syndrome with pancytopenia developed and persisted for many years, in the terminal phase of which as high as 16% of polymorphous reticular cells appeared in the peripheral blood. This represents a unique finding in idiopathic myelofibrosis syndrome. A detailed analysis of the pathogenesis of idiopathic myelofibrosis syndrome is considered both in terms of the clinical picture and course of the disease in this patient, as well as the results of the postmortem examination. It was classified as a case of myelofibrosis evolving terminally into a leukemic form of reticulosis. Pancytopenia in association with an enormously enlarged spleen was considered as a manifestation of hypersplenism, even in the absence of a positive Coombs test. However, the finding of megaloblastoid forms of erythroblasts in the spleen biopsy indicated a simultaneous aberration in the maturation process of erythropoiesis. The presence of Thorotrast in the reticular cells was found on histological examination of the spleen, bone marrow, and liver. To what extent the Thorotrast deposition was responsible for the pathogenesis of the persisting pancytopenia observed in this case could not be determined. (BBB)

20381 VENTRICULAR FUNCTION FOLLOWING RADIATION DAMAGE OF THE RIGHT VENTRICLE. Stone, H. L.; Bishop, V. S.; Guyton, A. C. (Univ. of Mississippi, Jackson). Amer. J. Physiol., 211: 1209-13(Nov. 1966).

The right ventricles of four dogs were exposed to 20,000 R ^{60}Co irradiation. The animals were carried through complete stages of: a) control studies for several weeks, b) irradiation, and c) postirradiation studies until death from typical heart failure 23–33 days later. Several different types of cardiac function curves were measured at intervals during the control and postirradiation periods. No evident deterioration of the ventricles could be discerned from the function curves during the first 14 days following irradiation. However, during the ensuing 9–19 days the ventricles deteriorated rapidly, as evidenced by deteriorating ventricular function curves, terminating in death. Ventricular function, as estimated by the method used in the present study, declined to an average of 43% below that of normal ventricles prior to death of the animal. (auth)

20382 CYTOLOGICAL AND HISTOLOGICAL MODIFICATIONS INDUCED BY COLLOIDAL ^{198}Au IN THE PALLIATIVE TREATMENT OF PLEURAL EFFUSIONS CAUSED BY NEOPLASTIC PROLIFERATIONS. Cruciani, V.; Loi, G. (Univ., Rome). Nunt. Radiol., 32: 490-6(June 1966). (In Italian).

Patients with malignant newgrowths of the lung and the mammary gland, complicated with pleural effusion, were treated by introduction of a ^{198}Au colloid preparation into the pleural cavity. Smears of the extracted fluid were then examined in order to observe changes induced by the radiations on the neoplastic and reactive cells present in the fluid. Negligible damage to the malignant cells and a marked desquamation of mesothelial cells were observed. It was concluded that the treatment did not arrest the formation of a new pleural effusion and did not sterilize malignant cells and tumoral foci. It was suggested that the stopping of the effusion was due to fibrosclerosis that was provoked by the application of radiant energy, which impermeabilized mesothelial sheaths. (auth)

20383 CANCER AND ITS RELATION TO ABNORMAL VAGINAL BLEEDING AND RADIATION. Paloucek, Frank P.; Randall, Clyde L.; Graham, John B.; Graham, Saxon (Roswell Park Memorial Inst., Buffalo). Obstet. Gynecol., 21: 530-42(May 1963).

The relation between abnormal premenopausal or menopausal vaginal bleeding and pelvic irradiation for benign gynecologic disease, with the subsequent development of cancer, was investigated from the case histories of 6767 women. A clinical diagnosis of uterine myoma was made in 64% of all patients, in 65% of those who had abnormal bleeding, and in 62% of those who had no abnormal bleeding. Of those who had hysterectomy, 92% had a clinical diagnosis of uterine myoma; of those who were irradiated, 70% had myoma; and of those who had neither hysterectomy nor irradiation, 42% had myoma. These patients were followed from 10 to 40 yr, with an average follow-up of 23 yr. The cause of death and subsequent development of cancer were ascertained in 97%. Life-table techniques were used to determine cancer-incidence rates. The treatment had generally consisted of both intrauterine radium and x-ray therapy, average dose of each being 2000 mg/hr and 500 to 1000 R delivered to center of pelvis. Patients with cancer of cervix received both radium and x-ray therapy, doses being 4000 to 9000 mg/hr and 2000 to 6000 R to center of pelvis. No correlation was found between incidence of cancer and previous irradiation, and the rate at which pelvic cancer developed in women who received pelvic radiation was unrelated to the quantity of radiation given. (BBB)

20384 CONTROL OF THE QUEENSLAND FRUIT FLY BY GAMMA IRRADIATION. Macfarlane, J. J. (CSIRO, Ryde, Australia). J. Econ. Entomol., 59: 884-9(Aug. 1966).

Possibilities were investigated of using ionizing radiation to exterminate the Queensland fruit fly, Strumeta tryoni, a serious economic pest in many areas along the east coast of Australia. The lethal effect of ^{60}Co γ radiation on the developmental stages of the fly was investigated. A dose of 80 Krad or more was required to kill within 1 day all eggs and larvae treated, but a dose of 5 Krad prevented the emergence of adults under normal growing conditions at 25°C. Fractionation of the total radiation dose, or treatment of the larvae at lower temperature, or in a sealed container, was less effective. The radiation resistance of pupae for the first 5 days after pupation was similar to that of mature larvae, the LD_{50} being near 1.5 Krad. Resistance increased rapidly as the pupae aged. The LD_{50} exceeded 50 Krad for pupae 10 days old. For quarantine purposes a dose near 5 Krad was suggested for the treatment of fruit infested with the Queensland fruit fly. (BBB)

20385 ABSCOPAL AND DIRECT EFFECTS ON CALCIUM MOBILIZATION, ALKALINE PHOSPHATASE LEVELS, AND DENTIN FORMATION FOLLOWING X-IRRADIATION OF EITHER THE RAT INCISOR OR THE THYROID-PARATHYROID REGION.

Collett, William K. (Univ. of Maryland, Baltimore); Watson, Joseph A.; Wald, Niel. J. Dent. Res., 45: 1529-30(Sept.-Oct. 1966).

Rats received 900 R of x radiation to either the area of the developing maxillary incisors (head) or to the thyroid-parathyroid region. Each animal was given an intraperitoneal injection of ^{45}Ca immediately following irradiation. At 1, 4, 8, 12, 17, 20, 24, 28, and 32 days postirradiation the rats were weighed, examined for evidence of gross pathology, and the 2 maxillary incisors, right femur, and other requisite tissues were taken for determination of their radiocalcium, total Ca, and/or alkaline phosphatase content. The head-irradiated and thyroid-parathyroid-irradiated animals showed similar patterns in mean radiocalcium uptake by their maxillary incisors. A significant decrease in radiocalcium uptake at 4 days postirradiation was followed by a generalized increase in ^{45}Ca uptake over control values after this period. The head-irradiated animals, however, showed distinct radiographic and histologic evidence of odontogenic disturbance in the developing maxillary incisors after 8 days postirradiation. This disturbance was manifested as an area of reduced radiographic film density and histologically as disruption of the odontoblastic cell layer, osteodentin formation, and/or the presence of a dentinal niche. No such evidence of odontogenic disturbance was noted in either the control or thyroid-parathyroid-irradiated animals. The extractable alkaline phosphatase levels in the maxillary incisors of the head-irradiated animals were reduced significantly from control incisor values. Little decrease was noted in enzyme level of the incisors from the thyroid-parathyroid-irradiated animals. No relation seemed to exist between the level of this enzyme in the maxillary incisor and the degree of tooth calcification. It was concluded that a definite difference in odontogenic response of the maxillary incisors occurred following direct (head) irradiation of this structure as compared to the abscopal or indirect effects on tooth formation from irradiation of the thyroid-parathyroid area. However, both groups showed altered Ca mobilization patterns in the maxillary incisors as compared to the control animals. (BBB)

20386 CHANGES IN SERUM LACTIC ACID DEHYDROGENASE FOLLOWING COMBINED IRRADIATION. Volek, V.; Dienstbier, Z. (Charles Univ., Prague). Acta Univ. Carolinae, Med., Suppl. 21: 175-8(1965).

A radiosensitive SH-dependent enzyme, serum lactic dehydrogenase (SLDH), was elected for the study of postirradiation enzyme activity. SLDH activity was followed in rats prior to irradiation as well as thereafter (at intervals of 4 and 24 hr, on the 5th day, and at the end of the 1st, 2nd, 3rd, and 4th week). Changes in the levels of SLDH activity were recorded following various doses of external (25, 100, 600, and 1000 R) and of internal irradiation (10 to 100 μC ^{32}P), as well as after a combined irradiation. Hematologic examinations were performed simultaneously with enzyme activity assays. SLDH activity decreased over the first hours and days after irradiation, returning to normal values while the blood changes were worsening. The SLDH activity was found to decrease again during the early postirradiation phase in all groups of animals except those receiving 1000 R. The drop of SLDH activity was, however, not directly proportional to the radiation dose. The SLDH activity was not appreciably altered in the rats receiving 100 μC ^{32}P, and in those subjected to combined external and internal irradiation (100 R + 10 μC and 600 R + 100 μC, respectively), a significant increase in SLDH values occurred over the whole period of observation. These changes appeared to be proportional to the magnitude of the accumulated irradiation dose. The increase is explained by protracted injury to the hemopoietic system owing to the effect of combined irradiation. Combined external and internal irradiation is known to cause extensive bone marrow destruction in small lab animals, and bone marrow is known to be rich in LDH activity. The immediate rise may be caused by enzyme liberation from damaged blood cells; protracted bone marrow injury and a damage to other hematopoietic organs is capable of maintaining SLDH elevation even during the later stages of the postirradiation state. (BBB)

20387 LYMPHOPENIA INDUCED BY SPLENIC INTERSTITIAL IRRADIATION. LaFave, James W.; Lyne, Benjamin J.; Hauser, Charles W.; McKinely, C. Richard; Perry, John F. Jr. (Univ. of Minnesota, Minneapolis). Surg. Forum, 16: 85-7(1965).

This study was designed to determine if lymphopenia can be produced by interstitial irradiation of the dog spleen. Use of tracer ^{51}Cr-labeled plastic microspheres (dia 15 μ) verified that such spheres, injected into the splenic artery, embolize in the spleen with insignificant loss via arteriovenous shunts into general circulation. Following ligation and division of the short gastric arteries to prevent loss of the injected spheres via collateral circulation, 15-μ ^{90}Y-tagged microspheres were injected into the splenic arteries of 9 dogs. Radioactivity was well localized and uniformly distributed in the spleens of all dogs. The operative procedure and irradiation were well tolerated. Lymphopenia occurred promptly; however, hemoglobin and granulocytes were unaffected. At 24 hr, circulating lymphocytes averaged 70% less than the preoperative control level, absolute counts being <1000/mm^3. Max response occurred 2 weeks postirradiation with an average decrease of 80%. Spleens biopsied at this time were virtually devoid of lymphocytes. Polymorphonuclear infiltrate and pigment-laden macrophages dominated the histologic picture. At 6 months postirradiation, reticulum cell hyperplasia was prominent but was associated with lymphoid repopulation. (BBB)

20388 DELAYED HYPERSENSITIVITY TO TRICHINELLA SPIRALIS ANTIGENS IN IRRADIATED GUINEA PIGS. Kim, Charles W. (Brookhaven National Lab., Upton, N. Y.). J. Parasitol., 52: 722-6(Aug. 1966).

Development of the delayed type of hypersensitivity to T. spiralis antigen in the guinea pig was not inhibited by total-body x irradiation at doses up to 200 R when administered 18 hr prior to sensitization with antigen plus adjuvant. An x-ray dose of 200 R, however, seemed to inhibit partially the appearance of antibody in some animals for 21 days following sensitization as determined by the passive cutaneous anaphylaxis test and seemed to inhibit the appearance of precipitating antibodies altogether. A decrease in the percentage of lymphocytes in irradiated animals may be responsible for the inhibition of antibody formation and for the failure of passive transfer by splenic cells. Irradiation may not have accounted for the failure of splenic cell transfer altogether since cells from nonirradiated donors also gave negative results. However, lymphocytes are important in cell transfer because they are responsible for the transfer of delayed hypersensitivity. Other evidence suggested that not only a min threshold of committed lymphocytes but also the latent periods in the donors as well as in the recipients are important in the transfer of the hypersensitive state by means of cells. (BBB)

20389 ABOUT CERTAIN PECULIARITIES OF BIOLOGICAL ACTION OF UV RAYS WITH DIFFERENT WAVELENGTH. Vorab'eva, I. A. (USSR Academy of Sciences, Moscow). pp 172-3 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

The effect of uv radiation of different wavelengths on the skin electrical conductivity, erythema reaction, and white blood cell count of rats was studied. Skin electrical conductivity was measured at 2 frequencies, viz. 10^6 and 10^4 Hz. The following sources of uv radiation were used: sun lamps (uv A, max 365 mμ), erythema lamps (uv B, max 310 mμ), and bactericidal lamps (uv C, max 254 mμ). Irradiation was done with different doses. The data obtained showed that the coefficient of skin polarization decreased after uv radiation, mainly in the low-frequency resistance range. Dependence of the skin reaction on the wavelength was observed: on irradiation with uv C (254 mμ) the coefficient of polarization began to decrease immediately after irradiation even before the appearance of erythema, on irradiation with uv B (310 mμ) only several hours afterwards, and in many instances only after the appearance of erythema. After irradiation with uv A (365 mμ) erythema did not appear and the coefficient of polarization did not change. The coefficient of polarization decreased more intensively, the more intense the erythema, and max erythema was always followed by a min value of the coefficient; with disappearance of erythema the coefficient returned to normal. Erythema and skin electrical conductivity are the indices of the local reaction. White blood cell counts were studied as an index of general reaction. The amount of leucocyte count increased after irradiation and a dependence of this reaction on the wavelength of irradiation was observed. After treatment by uv C, as a rule one maximum in the leucocyte count appeared in time; on irradiation with uv B and A two maxima appeared. (BBB)

20390 WHOLE-BODY IRRADIATION AND ACTIVE TRANSPORT IN THE RAT SMALL INTESTINE IN VITRO. Perris, A. D. (National Research Council, Ottawa). Radiat. Res., 29: 597-607 (Dec. 1966).

Three days after 600 rads of whole-body x irradiation, transport of a variety of substances by everted sacs of rat small intestine was studied. Transport of glucose, fluid, and propionate was inhibited. Galactose, 3-o-methyl glucose, sorbose, and L-histidine transports were not affected. The available evidence indicates that there is no decrease in the permeability of the epithelial cell membrane to sugars after irradiation and that permeability to fluid may even be increased. It is suggested that the inhibitions in transport are due to a block in a specific metabolic pathway and that this may be the aerobic glycolytic pathway. A decrease in the net sodium flux across the intestine, related to an increase in epithelial cell membrane permeability to small molecules after irradiation, could also be a factor in the inhibition of fluid transport. (auth)

20391 EFFECT OF IONIZING RADIATIONS ON CHOLESTEROL LEVELS OF ADRENALS, LIVER, AND PLASMA. Shel-

ley, Ruth N. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res., 29: 608-13(Dec. 1966).

Male white Sprague-Dawley rats exposed to $LD_{100(30)}$ of ionizing radiation produced by fission spectrum, thermal neutrons, and x rays showed a significant post irradiation increase of cholesterol levels in adrenal glands, liver, and, particularly, plasma. Fasting rats, which may show similar increases of cholesterol values in the liver (influenced by the accompanying weight loss) and in the adrenals, always showed lower plasma levels of cholesterol. (auth)

20392 TUMOR INDUCTION IN MICE BY RADIOACTIVE THYMIDINE. Baserga, Renato; Lisco, Hermann; Kisieleski, Walter E. (Northwestern Univ., Chicago. Argonne National Lab., Ill.). Contract AT(11-1)-1131. Radiat. Res., 29: 583-96(Dec. 1966).

Thymidine, a deoxynucleoside which is exclusively incorporated into nuclei of cells synthesizing DNA in preparation for cell division, was injected into C × A F_1 mice of different ages. When labeled with either ^3H or ^{14}C, thymidine increased the incidence of tumors and shortened the life span of C × A F_1 mice. The incidence of rare tumors was particularly increased, while tumors that are relatively frequent in this breed of mice, such as lung tumors and lymphomas, showed a shorter induction time. The life-shortening and carcinogenic effects of radioactive thymidine were more evident at high doses (about 10 uCi/gm of body weight with ^3H-thymidine) and in mice injected as newborn than in mice injected in adult life. Retention studies showed that radioactivity injected in newborn mice could still be detected in DNA of several tissues three years later. (auth)

20393 EFFECT OF ESTRADIOL AND IRRADIATION ON THE NUCLEIC ACID METABOLISM OF THE THYMUS, SPLEEN, LYMPH NODE, AND LIVER OF MICE. Thompson, John S.; Severson, Charles D.; Reilly, Richard W. (Univ. of Chicago). Radiat. Res., 29: 537-48(Dec. 1966).

The nucleic acid metabolism of the thymus, spleen, mesenteric lymph node, and liver was studied in adult female mice for 10 days after a single injection of estradiol or 150 R of total-body x-irradiation. The effect of estradiol was varied. First, it did not alter nucleic acid content (micrograms of nucleic acid per milligram of wet tissue weight) or synthesis (incorporation of radioactive nucleosides) in the mesenteric lymph node. Second, it enhanced DNA synthesis in both the spleen and liver and RNA synthesis in the spleen within 24 hours of administration. Third, estradiol, like x irradiation, caused thymic involution which was characterized by diminished nucleic acid content and DNA synthesis. X-irradiation also depressed nucleic acid content and DNA synthesis in the spleen and mesenteric lymph node, but only DNA synthesis was impaired in the liver. Enhanced RNA synthesis preceded the recovery of DNA synthesis and repair of the estradiol-injured thymus. This same sequence was clearly demonstrated in the thymus and spleen after irradiation, but the thymic response was distinguished by a second peak of RNA synthesis which appeared earlier than the second common peak. These findings may have particular bearing on the function of the mammalian thymus in the development and repair of lymphatic tissues and the immune system. (auth)

20394 LIVER PIGMENT, LIVER HISTIDASE, AND RENAL LYSOZYME CHANGES IN RELATION TO AGE IN NORMAL AND IRRADIATED SYRIAN HAMSTERS. Troup, Gary M.; Wagner, Inge; Walford, Roy L. (Univ. of California, Los Angeles). Radiat. Res., 29: 489-98(Dec. 1966).

Liver pigment, liver histidase activity, and renal lysozyme activity of the Bezanson strain of Syrian hamsters show an age-related increase. In contrast to histidase and lysozyme activity, the ethanol-nonextractable liver pigment differentiates young adult hamsters from old hamsters and thus is the best biochemical indicator of aging among the three determinations. A method for the direct quantitation of the nonextractable liver pigment is described. The between-species and between-strain variations of the two enzymes with age are discussed. The present data coupled with studies of collagen soluble/insoluble ratios in this same hamster population tend to suggest that x-irradiation-induced life-shortening differs from normal aging. (auth)

20395 IMPAIRED DEVELOPMENT OF RAT LIVER ENZYME ACTIVITIES AT BIRTH AFTER IRRADIATION IN UTERO. Smith, Carl Hugh; Shore, Moris L. (Public Health Service, Rockville, Md.). Radiat. Res., 29: 499-504(Dec. 1966).

Development of activity of three liver enzymes at birth was studied in rats receiving 180 rads of x rays on day 15 of gestation. At 20 days of gestation, activities of lactic and glycerophosphate dehydrogenases and glucose-6-phosphatase were not altered. The subsequent increases in enzyme activities in the 3 days between 20 days of gestation and 1 day of age were only 30 to 60% of those observed in controls. This finding suggests that irradiation in utero may alter later development of enzyme activity in the prenatal period. (auth)

20396 EFFECTS OF IRRADIATION AND STARVATION ON THE REGULATION OF RAT LIVER ENZYMES. Greengard, Olga; Baker, George T.; Horowitz, Maria L.; Knox, W. Eugene (Harvard Medical School, Boston. New England Deaconess Hospital, Boston). Proc. Nat. Acad. Sci. U. S., 56: 1303-9(Oct. 1966).

The elevation of liver enzymes by the administration of various substances was studied in adrenalectomized rats after whole-body x irradiation. Because irradiation alone almost eliminates food intake, irradiated rats were starved and compared to fed and starved adrenalectomized controls. Starvation greatly enhanced (2.5 to 3.5-fold) the response of tyrosine transaminase to hydrocortisone and increased its response to α-methyltryptophan and pyridoxine. Starvation did not enhance the response of tryptophan pyrrolase to any regulators. Irradiation did not diminish the response of either enzyme to hydrocortisone, but decreased the response of both enzymes to substrate-type compounds. The increase of tryptophan pyrrolase by its substrate analog was abolished after irradiation with 1600 R. The increase of tyrosine transaminase by α-methyltryptophan and pyridoxine was significantly inhibited by 800 R. These effects are different from that of puromycin, which inhibits both types of elevation of these enzymes, and different from actinomycin, which inhibits only the hormonal type of elevation. Irradiation, by inhibiting the substrate-type but not the hormone-type of elevation of these two enzymes, has an effect opposite to that of actinomycin. (auth)

20397 RECOVERY FROM SUB-LETHAL X-RAY DAMAGE OF SYNCHRONIZED HeLa CELLS DURING INHIBITION OF PROTEIN SYNTHESIS. Kim, J. H.; Eidinoff, M. L.; Laughlin, J. S. (Sloan-Kettering Inst. for Cancer Research, New York). Int. J. Radiat. Biol., 11: 509-11(1966).

Synchronized cells were used to confirm the existence of repair in the cell populations. Despite the progression of the cells toward a more radiosensitive phase, the surviving fraction of the cells increases following two split doses, implying a recovery process between fractions. Puromycin increased the extent of recovery relative to controls. This effect is consistent with considerations based on the radiosensitivity as a function of stage in the cell cycle. It is concluded that the mechanism of the repair process does not require uninterrupted protein synthesis. (C.O.)

20398 RESPONSE OF CELLS TO COMBINED ACTION OF X-RADIATION AND MUSTARD GAS. Castro, Victoria A.; Field, E. O.; Dawson, K. B. (Royal Marsden Hospital, Sutton, Eng.). Int. J. Radiat. Biol., 11: 513-15(1966).

HeLa and fibrosarcoma cells were treated with x rays and/or mustard gas. HeLa cells were more resistant to both agents. Graphs of the results of combined treatment show a second shoulder area when x irradiation was added to sulfur mustard treatment, indicating that the targets inactivated are different for these agents. (C.O.)

20399 ALTERATIONS IN TRYPTOPHAN METABOLISM IN MAN AFTER IRRADIATION. Smith, H. (United Kingdom Atomic Energy Authority, Chapelcross, Scotland); Langlands, A. O. Int. J. Radiat. Biol., 11: 487-94(1966).

Following a single exposure to x-rays at therapeutic dose-levels, alterations occur in the urinary excretion of three metabolites of tryptophan in man. In the 24 hours following exposure there is decreased excretion of indole acetic acid together with an enhanced excretion of 5-hydroxyindole acetic acid and indoxyl sulphate. (auth)

20400 FACTORS INFLUENCING THE APPARENT RADIOSENSITIVITY AND HEAT STABILITY OF ISOLATED LEUKOCYTE LYSOSOMES. Harris, John W. (Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales, Australia). Int. J. Radiat. Biol., 11: 465-76(1966).

The response of isolated leukocyte lysosomes to gamma radiation and to heat was directly related to the methods of preparation used. Lysosomes prepared with minimal damage were relatively sensitive to radiation damage; effects were observed after doses as low as 200 rads. Such lysosomes, in contrast to those prepared by more vigorous methods, were relatively stable during incubation at 28°C and were highly susceptible to mechanical damage. Addition of ions to the suspending medium resulted in an immediate increase in optical density and reduction in the turbidity changes and enzyme release during subsequent incubation. The extent of these effects varied with different ions and was not due to changes in the osmotic pressure of the medium. The possible relationship between these results and the wide range of radiosensitivity reported for lysosomes isolated from various tissues was discussed. (auth)

20401 EFFECT OF TOTAL-BODY X-IRRADIATION AND OF CHEMICAL PROTECTOR AET ADMINISTRATION ON THE ACTIVITY OF NUCLEAR RNA-POLYMERASE IN REGENERATING RAT LIVER. Vandergoten, R.; Goutier, R. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Int. J. Radiat. Biol., 11: 449-54(1966).

Nuclear RNA-polymerase activity has been measured in regenerating liver of rats which received before hepatectomy either an injection of AET or a whole-body x-irradiation of 1000 R or a combination of both treatments. AET injection, 1 hour before hepatectomy, delays the increase in enzyme activity still more than does irradiation. No protective effect of AET is observed in rats treated 1 hour before partial hepatectomy, probably because of the higher toxicity of AET to hepatectomized rats. A protective action is, however, detected when AET and irradiation are given 12 hours before partial hepatectomy. (auth)

20402 UREA AND AMMONIA CONTENTS OF THE LIVER AFTER IRRADIATION IN VIVO. Waldschmidt, Marianne (Univ., Freiburg i. B.). Int. J. Radiat. Biol., 11: 429-34(1966). (In German).

Three hours to 12 days after a whole-body x irradiation of mice with 690 R, the levels of urea and ammonia were determined in the liver. The ammonia level was increased from the 6th to the 12th hour and from the 2nd to the 8th day after irradiation, while the urea level was decreased from the 6th hour to the 6th day. Injection of ornithine intraperitoneally 15 min before liver removal led to a decrease in ammonia levels which was especially great p.r., but had no influence on urea levels. (auth)

20403 RADIATION EFFECTS ON DNA SYNTHESIS AND CELL DIVISION IN THE BONE-MARROW OF THE MOUSE. Frindel, E. (Gustave Roussy Inst., Villejuif, France); Charruyer, F.; Tubiana, M.; Kaplan, H. S.; Alpen, E. L. Int. J. Radiat. Biol., 11: 435-43(1966).

The radiosensitivity of C_3H mouse bone-marrow was measured at various times after a conditioning dose of 250 R x irradiation by a modified method of McCulloch and Till. There was a significant variation in radiosensitivity which is explained by partial synchrony of cells after the first dose of irradiation. The validity of the specific activity measurements of bone-marrow DNA as a test for synchrony is discussed. (auth)

20404 ANALYSIS OF THE PROGRESSION AND DEVELOPMENT OF METASTASES IN PATIENTS RECEIVING X-RADIATION IN HYPERBARIC OXYGEN. Van Den Brenk, H. A. S.; Madigan, J. P.; Kerr, R. C. (Cancer Inst., Melbourne). Clin. Radiol., 18: 54-61(Jan. 1966).

The incidence of metastases after radiotherapy treatment has been determined in patients with advanced cancers of the upper digestive and respiratory passages. The primary site and regional lymph nodes were treated with 4 MeV x-rays delivered either to conscious patients in air or to anaesthetised patients in hyperbaric oxygen (4 atmospheres absolute). High pressure oxygen treatments were associated with a significant reduction in the appearance of metastases after treatment—a finding attributed to improved clearance of tumor in the irradiated volume, and to the large tissue volumes irradiated in HPO. The view that HPO "stimulates" the growth of metastases was not supported by these results, nor by the results of HPO irradiation treatment of breast and selected abdominal cancers. The view is put forward that if certain HPO schedules used in radiotherapy do indeed potentiate growth of metastases after treatment, this may be due to the stress caused in conscious patients by repeated daily compressions spread over several weeks—protocols associated with apprehension, barotrauma and possibly fatigue. These could cause adrenocortical hyperactivity, and an endogenous liberation of corticosteroids which would favor a depression of immune reactions and a resistance of the host to neoplastic growth. Certain procedures used in the treatment of a cancer patient including surgery, inhalation anaesthesia, and radiotherapy may have the potential of causing adrenocortical hyperactivity and depressing host resistance to neoplastic growth. It is suggested that the investigation of such endocrinological disturbances may help to elucidate the possible effect of treatment (including hyperbaric oxygen) in enhancing the growth of metastases. (auth)

20405 CURRENT VIEWS ON THE RADIOBIOLOGY OF MAMMALIAN CELLS. Silini, G. (CNEN, Casaccia, Italy). Med. Nucl. Radiobiol. Lat., 8: 373-93(1965).

Recent data on the radiobiology of mammalian cells are reviewed and discussed, with special attention to the form of the survival curve and to the recovery phenomena brought about by the presence of a shoulder in this curve. (auth)

20406 EFFECTS OF SMALL DOSES OF GAMMA RADIATION ON THE DEVELOPMENT OF THE SKELETON IN THE CHICK EMBRYO. Juliani, G.; Randaccio, M.; Negri, G. L.; Mussa, A. (Univ., Turin). Med. Nucl. Radiobiol. Lat., 8: 447-59(1965). (In Italian).

Chick embryos were exposed on the 3rd day of incubation to small doses of radiation (30 and 50 rad) emitted by a ^{60}Co source. The irradiated embryos showed transient modifications of skeletal development: in particular, the rate of longitudinal growth of the long bones was slightly decreased. The changes were more pronounced between the 5th and 9th days of incubation. Perichondral and enchondral ossification showed a particularly marked reaction, with a decrease in the rate of growth of the basal layer, of the perichondral layer and of the enchondral osteogenic nuclei. No changes in the calcium content of the bone could be observed. All the changes observed were reversible—or at least appeared to be so, since none could still be found during the later phases of incubation or upon hatching. (auth)

20407 ULTRASTRUCTURAL ALTERATIONS OF THE IRIS OBSERVED SHORTLY AFTER IRRADIATION WITH NORMAL DOSES. Genovesi, E.; Micali, A. (Univ., Messina, Italy). Med. Nucl. Radiobiol. Lat., 8: 461-9(1965). (In Italian).

A study was made of the early developing ultrastructural modifications of the iris of rabbits after irradiation with doses of 300, 1500, and 3000 R emitted by a ^{60}Co source. After the doses of 3000 and of 1500 R no alterations could be observed; after the dose of 3000 R, on the other hand, some of the stromal cells presented saccular dilations of the perinuclear cisterna, especially in the external layer of the nuclear membrane. No alterations could be seen in the vascular endothelium, nor was there any dispersion of pigment granules. The findings described in this article are identical to those observed by the same authors and by other investigators in the cellular elements of various other tissues. It is concluded from the observations that the modifications in question are to be regarded as transient, not as irreversible. (auth)

20408 EXPERIMENTAL STUDY OF THE TOXIC EFFECTS OF COMBINED IRRADIATION AND 5-FLUOROURACIL TREATMENT. Bergonzini, R.; Morini, M.; De Maria, D.; Ferolla, G.; Torricelli, A.; Artusi, T. (Univ., Modena, Italy). Med. Nucl. Radiobiol. Lat., 8: 471-92(1965). (In Italian).

The study was carried out in 110 albino rats in order to determine the toxicity of separate and combined treatment with whole-body irradiation with ^{60}Co and intraperitoneal administration of 5-fluorouracil (5-Fu). Special attention was given to changes in body weight, and changes in the peripheral blood and bone marrow. This is only a preliminary report and certain limitations are stressed in regard to the conclusions. However, the following statements appear justified: 5-FU is at least partially radiomimetic in its toxic effects; if a combined treatment with ^{60}Co and 5-FU is administered, there is summation of the adverse effects of these 2 forms of therapy; the combination of ^{60}Co and 5-FU produces a less pronounced drop in the leukocytes than the postirradiation drop, but it lasts longer; and the biological responses of the animals differed depending on the type of association of the 2 forms of treatment (simultaneous, alternation, or in alternating cycles). (auth)

20409 THE EARLY DEVELOPING ULTRASTRUCTURAL ALTERATIONS OF THE BIPOLAR CELLS OF THE RETINA AFTER IRRADIATION WITH NORMAL DOSES. Micali, A.; Genovesi, E. (Univ., Messina, Italy). Med. Nucl. Radiobiol. Lat., 8: 217-26(1965). (In Italian).

A study was made of the early developing ultrastructural modifications of the bipolar cells of the retina of the rabbit irradiation with doses of 300, 1500, and 3000 R emitted by a ^{60}Co source. No abnormal findings could be seen after the doses of 300 and 1500 R. After 3000 R some of the stromal cells of the iris presented saccular and vesicular dilations of the perinuclear cisterna, especially in the external layer of the nuclear membrane; these alterations appeared two hours after the last irradiation. Results are compared with work done previously. It is concluded that the vesicles of the perinuclear cisterna may be regarded as morphological modifications that are a manifestation of the biochemical response to the irradiation in the transition zone between the nucleus and the cytoplasm which, because of the intensive metabolic exchange that takes place there, is particularly sensitive to radiation. (auth)

20410 ROLE OF A GERMINAL PLASM IN THE FORMATION OF PRIMORDIAL GERM CELLS IN RANA PIPIENS. Smith, L. Dennis (Argonne National Lab., Ill.). Develop. Biol., 14: 330-47(1966).

Ultraviolet irradiation of the vegetal hemisphere of Rana pipiens eggs, beginning the first cleavage division, with doses greater than 8000 ergs/mm^2 resulted in the complete elimination of primordial germ cells in 100% of the larvae that were otherwise apparently normal. Irradiation of the animal hemisphere with equivalent doses of UV had no apparent effect on the formation of primordial germ cells. The effect of UV on germ cell formation was greatest at the

time of the first division. After this, increasingly fewer eggs, which had been irradiated at the vegetal hemisphere, developed into larvae without germ cells. At the 8-cell stage, complete elimination of germ cells was not observed. Restitution of the germ line in irradiated eggs was obtained by injecting vegetal hemisphere cytoplasm from unirradiated eggs into the vegetal hemisphere of irradiated eggs, but restitution did not occur by injection of animal hemisphere cytoplasm. The UV action spectrum of germ cell inactivation suggests that the sensitive material is a nucleic acid. These results are consistent with the hypothesis of a specific cytoplasmic germinal determinant. This determinant is present only in the vegetal hemisphere cytoplasm; it is probably a nucleic acid; and it appears in embryonic development prior to the first cleavage division. (auth)

20411 PRECANCER OF SKIN. II. DIAGNOSIS AND TREATMENT. Davis, Jeff (Pack Medical Group, New York). N. Y. State J. Med., 66: 3043-53(Dec. 1, 1966).

Incidence, site of predeliction, pathology, and treatment of radiodermatitis are reviewed. Acute reactions from radiation are classified according to their severity as first-, second-, or third-degree radiodermatitis. Chronic roentgen dermatitis may follow many years after any one of these reactions. In chronic radiodermatitis the skin becomes excessively dry and parchment-like. It assumes a characteristic mottled or reticulated appearance with pigmentation, atrophy, and telangiectasis. Later keratoses, fissures, ulcerations, or nodules may appear and often are the predecessors of carcinomatous change. Cancer is usually of the squamous cell type. Up to 25% of cases develop malignant neoplasm of this type. Chronic radiation dermatitis invariably results in cancer, provided the patient lives long enough. Multiple cancers of the skin involved by chronic radiodermatitis appeared in from 27 to 31.5% of the 535 cases collected from the literature. In 24 of the author's 59 cases, or 40%, there was more than one carcinoma. Bland therapy, desiccation, or cautery excision of the occasional keratoses may be all that is necessary in the early period of chronic radiodermatitis. Small keratoses should be desiccated and larger ones surgically excised. Chronic late ulcerations are treated by application of mild ointments. If, after local medication, the ulcer does not respond, it should be excised surgically and plastic repair performed where necessary. (BBB)

20412 QUINETHAZONE PHOTOSENSITIVITY DERMATITIS. Miller, Richard C.; Beltrani, Vincent S. (Columbia Univ., New York). Arch. Dermatol., 93: 346-7(Mar. 1966).

A patient with a photosensitivity dermatitis to quinethazone who previously had similar reactions to chlorothiazide and hydrochlorothiazide is reported. Administration of the drug resulted in a flare of the eruption and uv light testing at this time demonstrated a decrease in the erythema threshold. Testing was performed with a fluorescent sun lamp as a light source, the emission spectrum of this tube being primarily between 2850 and 3300 Å, the erythema spectrum. Testing following quinethazone ingestion showed a considerable diminution of the erythema threshold. Peak erythema was achieved at 24 to 36 hr with subsequent gradual fading. The dermatitis flared after oral ingestion of the drug without subsequent solar exposure, and the sites of recent photo tests, which had not previously been involved and had shown a normal response to light testing one week before, also flared after ingesting quinethazone. Chlorothiazide, hydrochlorothiazide, and quinethazone are chemically similar. Quinethazone is a quinazolinone compound having only one sulfamyl group (monosulfonamide) instead of the 2 sulfamyl groups (disulfonamide) present in chlorothiazide. The ring sulfa 1,1-dioxide system is replaced in quinethazone by a cyclic carbamyl group. The action spectrum in photosensitization due to this group of drugs is in the uv wavelength range between 2750 and 3100 Å, and is thought to be a photoallergic rather than a phototoxic effect. This patient probably represents a photoallergic reaction in that a clinical history of photo cross-sensitization was present, and an extensive flare of the dermatitis occurred with administration of the drug. (BBB)

20413 RUBY LASER MICRO-IRRADIATION OF SINGLE TISSUE CULTURE CELLS VITALLY STAINED WITH JANUS GREEN B. I. EFFECTS OBSERVED WITH THE PHASE-CONTRAST MICROSCOPE. Amy, R. L.; Storb, R.; Fauconnier, B.; Wertz, R. K. (Centre National de Transfusion Sanguine, Paris). Exp. Cell Res., 45: 361-73(Feb. 1967).

Living KB tissue culture cells were vitally stained with varying low concentrations of Janus green B, then subjected individually to a microbeam from a pulsed ruby laser with a maximum output of 0.5 joule. The resultant radiation-induced cellular changes were visible under the phase-contrast microscope and were categorized on the basis of their magnitude according to a classification system that ranged from No. 1 (dark mass ca 2 μ^2) to No. 6 (cell fragmentation). It was found that a regular positive relationship exists between the size of the incident laser light dose and the amplitude of the induced damage. The same relationship held for each stain concentration studied. This demonstrates the feasibility of employing a ruby laser as a dependable source of monochromatic, spatially coherent light (6943 Å) in producing and studying predictable effects in single, living cells. Long-term studies showed that stained cells sustaining restricted light damage (damage category No. 1) survived for at least 56 hr and over 50 per cent of them were able to divide in apparently typical fashion. This survival time compared favorably with that observed in stained but unirradiated control cells, 77 per cent of which divided. Moderately damaged cells (categories No. 2 and No. 3) failed to divide and fewer than 10 per cent of them lived more than an average of 11 hr after being irradiated. (C.O.)

20414 INVESTIGATIONS ON COMBINATION INJURIES. PART 6. ON THE LIFE EXPECTANCY OF MICE, WHICH WERE BURDENED WITH WHOLE-BODY IRRADIATION IN COMBINATION WITH PEN OR CLOSED SKIN WOUNDS, ABDOMINAL OPERATIONS, OR COMPRESSION INJURIES. Messerschmidt, Otfried (Univ., Freiburg i. B.). Strahlentherapie, 131: 298-310 (Oct. 1966). (In German).

Male mice of an inbred strain were exposed to x-irradiation with 510 R (LD 26/30) and different stresses, such as open skin wounds, re-closed skin wounds, exploratory laparotomy, splenectomy, or compression damages. Irradiation and injury were varied in sequence and time interval. An increase in radiation mortality was observed when the various types of injuries were inflicted 2 to 8 days after irradiation. A significant decrease in radiation mortality was observed, if splenectomy, exploratory laparotomy, and reclosed skin wounds were done 1 hour after irradiation. Open skin wounds and splenectomy caused a decrease in radiation mortality, if done prior to irradiation. (auth)

20415 VLIV IONISUJICIHO ZARENI NA DRENOVOU KRVETVORBU. (The Effect of Ionizing Radiation on the Bone Marrow). Arient, Miloslav. Prague, Statni Zdravotnicke Nakladatelstvi, 1965. 123p.

Quantitative changes in absolute bone marrow cell counts in dogs and rats resulting from irradiation are considered to indicate the individual radiation resistance. Relative changes are less reliable. These conclusions were reached after study of the changes in the number of marrow cell types found after external x irradiation, after internal irradiation with radioisotopes (^{32}P, ^{51}Cr, and ^{65}Zn), and after a combination of external and internal irradiation. The reaction of myeloid and normoblasts to external irradiation did not differ quantitatively from that to internal. However, the reaction of the reticulocytes was quite different, the absolute numbers increasing after external irradiation but decreasing after internal. The mononucleocyte count increased after both external and gamma irradiation. After the combined external and internal irradiation, all types of cells showed an absolute decrease. 161 references; 41 photomicrographs. (TTT)

20416 BIOLOGY OF THE LABORATORY MOUSE. SECOND EDITION. Green, Earl L. (ed.). New York, McGraw-Hill Book Co., 1966. 713p. $16.50.

The biology of the mouse is presented as a ready reference for researchers who use laboratory mice. Information is included on the anatomy, physiology, development, reproduction, biochemistry, pathological conditions, immune traits, behavioral traits, genetics, techniques of husbandry, genetic nomenclature, and the response of mice to drugs, foreign tissues, and radiation. The development of recent mutations affecting biochemical traits, hemoglobin traits, and neurological traits, and genetic factors governing the transplantability of tissues between mice are discussed. (1693 references.) (C.H.)

20417 PYRIMIDINES AND THE X-RAY RESPONSE OF TRIBOLIUM CONFUSUM. Hogan, Gene Richard. Urbana, Ill., Univ. of Illinois, 1966. 109p.

Thesis.

The radiosensitizing effects of incorporation into DNA of the halogenated pyrimidines, 5-bromouracil or 5-iodouracil, or their nucleosides (BUdR or IUdR) have been demonstrated in a variety of cell types. At relatively low concentrations in the medium, the halogenated antimetabolities exhibit toxicity within one week after hatching of larvae in analog-containing medium. The toxicity of brominated analogs is less pronounced than that of the iodinated analogs and is slower to develop. Larval lethality attributable to toxicity and the lethality attributable to x rays are not clearly separable. The results obtained in this study indicate that the halogenated analogs tested influence lethality in x irradiated adult Tribolium. Toxicity of the halogenated pyrimidines or halogenated nucleosides is demonstrable three to five weeks following isolation of pupae into analog-supplemented medium. The brominated analogs are much more toxic to adults than 5-IU or IUdR. Analog-treated adults exposed to 7 Kr, which is sub-lethal for adults in

normal medium, die much earlier than those treated with analog alone or with supra-lethal doses of x rays alone. Adults isolated as pupae into unsupplemented medium, transferred to analog-containing ration after three weeks and irradiated immediately before transfer exhibit marked lethality within one week after irradiation. Transfer of adult beetles to normal medium after three weeks or less in the presence of halogenated analog virtually eliminates lethality attributable to the analog. X irradiation at the time of transfer, however, leads to high mortality. The onset of mortality occurs between the second and third week post-irradiation and is similar to that of supra-lethally irradiated adults in normal medium. The effects of BUdR or IUdR on adult X-ray lethality persist one to two weeks after analog exposure. Insects grown for twelve weeks in medium containing uracil or thymine exhibit the same survival as those reared in unsupplemented medium. Two weeks after 7 Kr-irradiation a sharp decline in survival is seen in both uracil- and thymine-treated groups. No such response is observed in purine-treated Tribolium or adults treated with 5-aminouracil, 6-azathymine or 6-azauracil. (Dissertation Abstr.)

20418 THE EFFECTS OF GAMMA IRRADIATION (^{60}Co) ON THE DEVELOPING TESTES AT SPECIFIC INTERVALS DURING PRENATAL AND POSTNATAL DEVELOPMENT IN TWO STRAINS OF ALBINO RATS. Green, Don Carroll. College Station, Tex., Texas A and M Univ., 1966. 105p.

Thesis.

A study was conducted to obtain data on effects of chronic low level radiation on the developing testes at specific intervals during pre- and postnatal development in two strains of albino rats. The investigation was divided into four phases: Phase 1 consisted of seven groups of Wistar rats receiving 0, 1, 2, 5, 10, 20, and 40 R per day respectively administered from day 15 prenatal to day 3 of postnatal life. Phase 2 was exactly like Phase 1 in all particulars except that the test animals were albino rats of the Sprague–Dawley strain. Phase 3 consisted of seven groups of Wistar rats subjected to the same dosages as test animals in Phases 1 and 2, but in Phase 3 animals were irradiated from day 3 to day 13 of postnatal life. Phase 4 consisted of five groups of Wistar rats receiving 0, 5, 10, 20, and 40 R per day respectively administered from day 3 to day 23 of postnatal life. All test animals were weighed at birth, weaning, 65 days, and 170 days. Testes cross sections from rats in all groups of the four phases were examined to determine total number of tubules, number of active tubules, number of inactive tubules, average diameter of active and inactive tubules as measured in microns, and number of germinal cells per ¼ of testes cross section. Accessory reproductive organs were also examined for evidence of damage. A total dose of 400 R was found to cause a significant difference in body weights, while treatment groups subjected to lesser doses did not differ from controls in this respect. Fertility tests revealed that males in Phases 1, 2, and 3 exposed to 1, 2, 5, and 10 R per day did not differ from controls since these groups produced litters similar to those of the controls. Animals exposed to 10 R per day were fertile and did produce offspring, though there was a significant difference from the controls in histological data at this level of radiation. In Phases 1 and 3 (Wistar rats) the 20 R per day groups produced offspring, but in Phase 2 (Sprague–Dawley rats) the 20 R per day group failed to produce offspring. Histological data for the Sprague–Dawley strain revealed that the number of active tubules was greatly reduced as compared with the number of active tubules for Wistar rats receiving the same level of irradiation. (Throughout the study Wistar rats were found to be more radioresistant than Sprague–Dawley rats.) Histologically, animals receiving 1 and 2 R per day were not different from the controls. At 5 R per day only the rats irradiated from day 15 prenatal to day 3 of postnatal life showed histological damage to the testes. This damage was not evidenced at 170 days, indicating that regeneration of germinal epithelium had taken place by this time. Animals receiving 10 R per day (total dose 100 R) showed damage which was still apparent at 170 days, but though permanent histological damage was thus evident, the animals were not found to be sterile at 143 days of age. Administration of 20 R per day for a total dose of 200 R caused permanent sterility in the Sprague–Dawley rats, but Wistar rats exposed to the same dose were able to produce some litters. A dose of 40 R per day for a total dose of 400 R caused complete destruction of the germinal epithelium in both strains. This study supports the original hypothesis that the greater portion of irradiation damage to the developing testes occurs during the period of extreme radiosensitivity from day 15 prenatal to day 3 of postnatal life. (Dissertation Abstr.)

Radiation Effects on Plants

Refer also to abstracts 20085, 20116, 20121, 20125, 20126, 20144, 20146–20151, 20233, 20287, 20321, and 20455.

20419 (COO–1512-3) APPLICATION OF BIOMETRICAL GENETIC TECHNIQUES TO IRRADIATED AND NON-IRRADIATED POPULATIONS OF CORN TO PROVIDE INFORMATION ON NATURE OF GENE ACTION INVOLVED IN THE INHERITANCE OF QUANTITATIVE TRAITS AND IN HETEROSIS. Technical Progress Report, 1966–67. Gardner, C. O. (Nebraska Univ., Lincoln). Contract AT(11-1)-1512. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results are reported from an analysis of genetic variation in populations of up to 19 selected generations of corn of the Hays Golden variety grown from seeds exposed to single or recurrent treatment with thermal neutrons, non-irradiated seeds, or crosses of irradiated and normal plants. Emphasis was placed on mass selection for grain yield and stalk strength. No evidence of heterosis in the crosses was observed and it was concluded that selection increased the frequencies of some favorable genes in all populations. Yield responses of mass-selected control and irradiated populations did not differ significantly. Selection for yield also resulted in plants that were taller and later maturing. Data are tabulated on genetic parameters examined, results of analyses of variance, and percent of total variation among populations attributable to the different parameters. Data are included from studies on the effects of irradiation and selection on the frequency of deleterious recessive alleles in Hays Golden corn, the kinds and amounts of genetic variations in various populations as compared to the original population from which they were derived, and genetic investigations of three mutant types induced in inbred lines of corn from seeds exposed to thermal neutrons. Studies on the effect of thermal neutron irradiation of seeds and uv irradiation of pollen on homozygous lines of corn, and the effects of x radiation exposure of seeds on genetic variability in corn populations, and the effects of treatment of pollen of corn for various lengths of time with vapor from ethyl methane sulfonate on mutations in grain yield and other quantitative traits are reported in progress. Results are also included from studies on the effects of environment on genetic variation in Arabidopsis thaliana of the Cruciferae (mustard) family. (C.H.)

20420 (COO–1625-7) FACTORS AFFECTING MITOTIC CYCLES IN MERISTEMS. EFFECTS OF IAA ON COLCHICINE INDUCED CHANGES IN MITOTIC ACTIVITY AND ROOT GROWTH. Report [Covering Period] 1966–1967. Davidson, D. (Western Reserve Univ., Cleveland, Ohio. Dept. of Biology). Feb. 25, 1967. Contract AT(11-1)-1625. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Roots of Vicia faba were treated for various time intervals with various concentrations of colchicine or indole acetic acid, alone or combined, and the effects of the treatments on the mitotic cycle in meristems and primordia were determined in serial fixations made periodically for 36 hr. Whole growing root systems were treated for up to 24 hr with 5-aminouracil and mitotic indices and the number of chromosome aberrations in primary and lateral roots and large and small primordia were determined periodically for 24 hr. The uptake of ^{3}H-thymidine was used to determine the duration of the mitotic cycle in root cells. Preliminary results are reported on studies on the effects of x radiation on mitosis in roots treated with colchicine before irradiation. (C.H.)

20421 (NYO–3561-3) PROGRESS REPORT [ON USE OF TRITIATED THYMIDINE AS INTERNAL SOURCE OF RADIATION IN STUDY OF LATERAL ROOT INITIATION], 1965–1966. Stein, Otto L. (Massachusetts Univ., Amherst). Jan. 25, 1967. Contract AT(30-1)-3561. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effect of concentration of isotope/root as opposed to concentration/volume of solution was determined. It seems clear that especially at low concentrations of the isotope (and high specific activity?) the amount of tissue treated becomes important. Tritiated water at ca. 25 mCi/root will inhibit lateral roots over the entire treated region. In that respect the results resemble the effects of x rays. Tritiated thymidine at 50 μCi/root will inhibit lateral formation in the differentiating pericycle. Both scoring of labeled nuclei and scintillation counting indicate that this tissue incorporates ^{3}HT much more actively than the surrounding portions of the root. Roots in culture are much more sensitive to ^{3}HT than intact seedlings. (auth)

20422 (NYO–3571-4) THE EFFECTS OF IONIZING RADIATION ON THE GENETIC STRUCTURE OF HETEROZYGOUS OUTBREEDING POPULATIONS OF FOREST TREES. Progress Report Covering Year Two of a Planned Five-Year Program, June 1, 1966–May 31, 1967. Stairs, Gerald R. (State Univ. of New York, Albany. Research Foundation). Contract AT(30-1)-3571. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on studies on the effects of various doses of γ radiation on mature pollen of various species of forest trees as measured by seed set, seed germination, and progeny develop-

ment. Data are presented from germination trials of seed samples. Results are reported on a hierarchical mating design in Picea glauca, using 5 female and 15 male trees in each of two areas, with γ irradiated and control pollen used in each cross; a study on the radiosensitivity of pollen of Picea glauca in two areas with different environments exposed to γ radiation doses ranging from 0 to 400 kR; the radiosensitivity of pollen of Pseudotsuga mensiesii or Larix decidua exposed to γ radiation doses ranging from 0 to 400 kR; a hierarchical mating design in Larix leptolepis, using 5 female and 15 male trees in each of two areas, with pollen irradiated at 4 kR and control pollen; and a clonal repeatability study with somatic irradiation of Populus tremuloides clones. (C.H.)

20423 (ORO-2583-1) A CYTOLOGICAL STUDY OF RADIATION INDUCED ALTERNATIONS IN CYTOPLASMIC FACTORS CONTROLLING MALE STERILITY IN CORN. Progress Report. (Florida Agricultural Experiment Station, Gainesville). Dec. 1, 1966. Contract AT(40-1)-2583. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Backcrossing fertile selections, from γ-irradiated corn seedlings containing T-type cytoplasm, by non-restover lines was carried out. The production of progenies containing only fertile plants supported the assumption that irradiation altered or inactivated cytoplasmic sterility factors. Ovule, anther, leaf, and root tissue from some of these fertile selections were compared cytologically with tissue from male sterile, maintainer and retored tissue. No consistent differences in cytoplasmic constituents were observed with the electron microscope. Evidence for paternal transmission of T-type cytoplasmic sterility factors is being investigated by initially crossing some of the male sterile and partially sterile plants with pollen from maintainer lines and then checking for maintainance of male sterility in progeny. A comparison of seedling heights over a 4 wk growing period was made on reciprocal hybrids of Mexican June and Tx341 and Mp462 inbreds. Seeds were treated with 10,000 to 30,000 R. Analysis of variance showed no significant differences in seedling height that could be attributed to differences in cytoplasm. Mp642 was more resistant to radiation damage than Tx341. Examination of epidermal strips from Moldairan male sterile (S type) ♀ × Ioana ♂ and Ioana sweetcorn seedlings revealed the presence of needle-like inclusions in some accessory cells. The inclusions consisted of flat plates apparently all oriented on edge and they occurred within one accessory cell of a group of accessory cells in both sterile and maintainer lines. The apax width of lodicules from Fla. F6 × T × 61M and from Fla. F6T × T × 61M unopened spikelets was measured. A significant difference in width was found; the lodicules with sterile cytoplasm had an average width of 0.84 mm while those with normal cytoplasm had an average width of 0.93 mm. in ultrathin sections the lodicules from male sterile florets carrying S-type cytoplasm exhibited convaluted cell walls and greatly reduced intracellular spaces; lodicules of both maintainer and sterile florets had transparent appendages originating at the tip. (B.H.S.)

20424 (ORO-3094-1) A STUDY OF THE RELATIONSHIP BETWEEN PLANT WATER STRESS AND IONIZING RADIATION. Final Report for the Period January 1965–May 1966. (Duke Univ., Durham, N. C.). Feb. 2, 1967. Contract AT(40-1)-3094. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two-year-old pine (Pinus taeda) seedlings were subjected to high or low water stress (–7.7 atm of –5.3 atm measured in excised leaves) during 12 to 30 days exposure to doses of 0, 20, 30, or 50 R chronic γ radiation per day. High water stress inhibited needle elongation about equally in all seedlings except those irradiated with 50 R/day for 30 days. Radiation effects were almost identical at all levels of water stress in seedlings irradiated during dormancy. A study of the mechanisms of interaction of water stress and irradiation indicated that water stress slows the rate of cell division in pine meristems and results in larger radiation doses during each interphase. No variation in radiosensitivity due to ecological conditions was observed in preliminary studies. (C.H.)

20425 (STI-DOC-10/66) ISOTOPES AND RADIATION IN PLANT PATHOLOGY. Technical Reports Series No. 66. (International Atomic Energy Agency, Vienna (Austria)). Sept. 1966. 100p. IAEA: $2.50; Austrian Schillings 65,-; 17/8 stg; F Fr 12,30; DM 10,-.

Eleven papers discuss the application of radiation and radioisotopes in plant pathology. The topics discussed include the use of radioisotopes to study the spread of plant parasites; the use of induced mutations for breeding disease-resistant plants; the use of radiation and radioisotopes for study of plant tumors; biochemical factors affecting sporulation of fungi that cause diseases of plants; the toxicity and mode of action of fungicides; the effects of rusts on the physiology of host plants; the use of isotopes in studies of processes of virus infection of plants; the characteristics of RNA in tobacco mosaic virus and its role in the infection of tobacco plants; the use of radiation and radioisotopes for studies on the biology of nematodes and their relationships to the host plant; and the present status of the use of isotopes and radiation in studies of plant pathology. (464 references.) (C.H.)

20426 (UCB-34P50-4) AN INVESTIGATION INTO THE UTILITY OF RADIATION STERILIZED SOIL AS A MEDIUM FOR GROWTH OF PLANTS AND MICROORGANISMS. Progress Report, January 1–December 31, 1966. McLaren, A. Douglas (California Univ., Berkeley. Dept. of Soils and Plant Nutrition). Feb. 1, 1967. Contract AT(11-1)-34. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Studies based on the finding that soils may be sterilized with ionizing radiation without loss in enzyme activity are reported. Measurements of phosphatase activity in soil undertaken to determine the amount of soil enzyme activity that is extracellular showed that half of the soil phosphatase activity is in the nonliving moiety of soil. It was found that basic proteins can enter plant roots and inhibit root growth without decreasing yields of tops. Inhibition of root growth was shown to occur in the presence of histones, protamines, and polylysine, and the ability to inhibit growth appeared to be a general property of basic, high molecular weight substances. Furthermore, the uptake of proteins by roots, and the entry of proteins into root cells seemed to be found in a wide range of plants, including: vetch, tomato, onion, barley, and maize. The use of autoradiography and fluorescence microscopy in the studies is discussed. (H.G.D.)

20427 (JPRS-39158) STUDIES ON THE MUTAGENIC ACTIVITY OF A NEW GROUP OF CHEMICAL COMPOUNDS AND THEIR GENETIC EFFECT WHEN COMBINED WITH IONIZING RADIATION. Suykova, L. A. Translated from Izv. Akad. Nauk SSSR, Ser. Biol., 31: 739-43(1966). 8p. (TT-66-35581). CFSTI $3.00 cy, $0.65 mn.

The alkylating compounds K_{32}, C_{32}, and K_{16}, tested for the first time on second generation burley (M_2) by the chlorophyll mutation criterion, proved to be active mutagens and well worth using for plant selection. The most active was K_{32}, which produced 16 to 42% changed seeds. The resultant mutation spectrum was also wider than that produced by the other mutagens. For example, the rare striata and tigrina mutations were produced only by K_{32}. The frequency and spectrum of mutations differed sharply in the two experiments described. Since the seeds used in the experiments came from the same ear, the difference in results was obviously due to the difference in surrounding conditions. The combined action of chemical mutagens and radiation did not produce a distinct summational effect. The results apparently varied with the conditions under which the experiments were performed. (auth)

20428 EFFECT OF GAMMA RAYS ON GERMINATION IN SOLANUM KHASIANUM CLARKE. Patil, R. P. (Botanical Survey of India, Calcutta). Curr. Sci. (India), 36: 131-2(Mar. 5, 1967).

Results are reported from studies on the effects of doses of 1500, 3000, and 6000 R of γ radiation on the germination of seeds of Solanum khasianum. (C.H.)

20429 X-RAY EFFECTS ON BARLEY ROOTS. II. SINGLE AND FRACTIONATED EXPOSURE. Kiefer, Juergen (Inst. of Biophysics, Giessen, Ger.). Int. J. Radiat. Biol., 11: 373-82 (1966).

The effects of x rays on barley roots are described and interpreted in terms of a model of the meristem cell population kinetics. With the aid of this model cell survival curves could be deduced for the meristem cells. The effect of dose-fractionation has also been studied and an Elkind-type of recovery has been found also for this system. (auth)

20430 ON THE ROLE OF BORON IN THE THERMAL NEUTRON SENSITIVITY OF PLANTS. Ecochard, R.; Oosterheert, W. F. (Association EURATOM-ITAL, Wageningen, Netherlands). Int. J. Radiat. Biol., 11: 385-7(1966).

Vicia faba plants were grown on nutrient media containing boric acid having concentrations of 5% ^{10}B or 91% ^{10}B. Damage at the chromatic level was measured by the number of micronuclei present in the tetrads 24 hr after irradiation with thermal neutrons. Plants grown on the higher concentration of ^{10}B were significantly more susceptible. Analysis is based on the difference in available cross-sections of ^{10}B. Up to 2 hr irradiation time the dose-response relation is linear, but above 2 hr, damage does not increase. This plateau is not explained. (C.O.)

20431 A COMPARATIVE STUDY OF THE ANTIMITOTIC EFFECTS OF m-XYLOHYDROQUINONE, 2,6-DIMETHYLPHENOXYACETIC ACID AND IONIC RADIATIONS ON ALLIUM CEPA. Sanyal, S. N.; Chatterjee, Prabir (Calcutta Bacteriological Inst., India). Nucleus, 9: 77-82(June 1966).

Onion root tips were subjected to the chemical agents at concentrations of 0.0005 to 0.01 M and to 300 R doses of γ or x radiation. In this comparative study, a close similarity was observed in the chromosomal rearrangements in mitosis with all 4 treatments tested, namely, m-xylohydroquinone, 2,6-dimethylphenoxyacetic acid, x irradiation, and γ radiation from Ra. Arrest at metaphase was evident. Fragmentation, pyknosis, and anaphase bridge formation were evident with both the treatment with the chemotherapeutic agents and the radiations. Restoration in Knop's solution even after 72 hr was not detected with these chemotherapeutic agents. These changes are depicted in photomicrographs. Additional experiments using spectrophotometric analysis indicated that m-xylohydroquinone interacts with DNA. Pure DNA has an absorption maxima at 260 mμ. When m-xylohydroquinone interacted with DNA the absorption maxima also appears in the same region, i.e., 260 mμ, but the absorption density was much increased. Depolymerization of DNA results in an increase of absorption density at 260 mμ. (BBB)

20432 AN IMPROVED STRAIN OF OATS DEVELOPED FROM ALAMO BY IRRADIATION WITH X RAYS. Lewis, R. D. (Texas A and M, College Station). Tex. Agr. Exp. Sta., Leafl., L-563, 4p (Mar. 1962).

Alamo-X, a new variety of oats developed by the Texas Agriculture Experiment Station and the U. S. Department of Agriculture, is being distributed to replace Alamo because of its greater resistance to Helminthosporium blights and certain races of crown rust, its greater tolerance to low temperatures, and its good forage characteristics. Its yield is similar to that of Alamo. The new strain, Alamo-X, was selected from the fifth generation progeny lines from Alamo seed subjected to 25,000 R of x irradiation. Starting with the fourth generation, all blight-resistant progeny were screened for reaction to crown rust race 216 and the fifth generation were screened to race 290 which had become prevalent. In 1959, 60 strains were tested in preliminary yield trials, from which three were selected for seed increase. In 1961, 600 bushels of strain Alamo-X (experimental strain 2276-2, C.I. 7648) were made available to seed growers. While it cannot be proved whether the changes in Alamo came about by mutation caused by the x rays or from natural crossing as a result of sterility caused by the x rays, the method has provided a new variety with improved characteristics in a relatively short time as compared with conventional breeding methods. (BBB)

20433 PHOTOREVERSIBLE EFFECT OF ULTRAVIOLET LIGHT ON CHLOROPLASTS. Chessin, M. (Montana State Univ., Missoula). pp 282 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

In experiments on the mechanism of photoreactivation of uv-irradiated bean leaves, photoreversible disappearance of the chloroplasts in the guard cells of epidermis stripped from such leaves 24-hr after dark incubation was observed. Starch also disappears from such plastids, which may partly account for the results. Unexpectedly, even when leaves were given 10 times the minimal dose for plastid disappearance, a high percentage of those few stomata which were still open functioned osmotically, as indicated by reversible plasmolysis-deplasmolysis. In a study of uv irradiated plastids by fluorescence microscopy, when no guard cell plastids could be observed by ordinary light or phase optics in irradiated leaves, discrete spots with the characteristic red fluorescence of chlorophyll were seen easily. At higher uv doses, however, even these fluorescent spots disappeared. Apparently, there is some loss of plastid structure as a result of uv treatment (2537 Å) as indicated by observations with ordinary light or phase microscopy. However, the results of fluorescence microscopy show that the chlorophyll-binding skeleton is more resistant to uv than some other parts of the plastid. (BBB)

20434 IRRADIATION-INDUCED QUANTITATIVE VARIATION OF RICE WITH REFERENCE TO ITS EFFECTS OF SELECTION. Hu, Chao-hwa (Taiwan Provincial Chung-Hsing Univ., Taichung, China). Proc. Nat. Council Sci. Develop. Rep. China, No. 1, 121-37(Dec. 1965). (In Chinese).

Two native Taiwan rice varieties (I-Kung-Pao, Woo-co-chin-yu) and two Ponlai varieties (Chai-nung 242, Taichung 179) were treated with 15, 20, and 25 kR of x rays or thermal neutrons to investigate the effect on plant height, panicle length, panicle number, and heading time. Field experiments were used with randomized block design, with three replications of a single plant per hill. The variations observed in the 2nd generation after treatment are described. Based on the mean value of the treated population analyzed by the hierarchical classification method, the experimental errors reached significance in nearly all characters, and no significant differences could be found for different doses of treated and nontreated seeds. The genetic variance of the treated population was larger than that of the nontreated. (BBB)

20435 THE INFLUENCE OF CHRONIC IRRADIATION OF PEAS WITH GAMMA RAYS ON THE FORMATION OF NODULES. Hamatova, E. (Central Research Inst. for Plant Production, Prague). Rostlinna Vyroba, 39: 15-21(1966). (In Czech).

The effect of γ radiation at cumulative doses of 5551 to 18,820 R in field experiments on the fixation of nitrogen on roots of pea plants by Rhizobium leguminosarum was studied. Chronic irradiation of pea plants with doses of 7057 to 18,820 R inhibited, in plants of different stages of development, the formation of nodules on the roots and the accumulation of nitrogen in the plants. Irradiation under the same conditions with a dose of 5551 R also decreased the weight of the dry substance of the plants and the fixation of nitrogen, but the formation of nodules was not affected unfavorably. Chronic irradiation of peas with γ rays at doses of 33,151 to 55,860 R decreased development of nodules on the roots. The strains of R. leguminosarum isolated from the nodules of the plants that had been irradiated with 55,860, 40,981, and 33,151 R could be maintained in fresh media for one yr, whereas the strains that had been isolated from the roots of plants irradiated with 18,820, 12,703, 7057, and 5551 R could not be cultured for longer than 2 to 4 months. (BBB)

20436 EFFECT OF SHORTWAVE RADIATION ON THE BRIGHT RED-DARK RED ANTAGONISM ON SOME PHOTOMORPHOSES OF TRITICUM VULGARE AND LACTUCA SATIVA. Schoenbohm, Ekkehard (Univ., Erlangen-Nuremberg, Ger.). Z. Botan., 52: 335-45(Dec. 1964). (In German).

Three phytochromal reactions in plants were tested as to uv-stabilizing effects. It was shown that the bright red stabilizing effect of uv was independent of a subsequent dark red irradiation, as related to epinasty of the primary leaves of Triticum seedlings and for the plumula hook flexure of Lactuca seedlings. The reaction induced by uv was not, as the bright red induction, obliterable by dark red induction. In studies of achaenia germination with Lactuca uv had no effects on bright red-dark red antagonism. Alone, uv was not able to induce germination. Irradiation with uv between the bright red and the dark red phase increased the damping effect of the dark red considerably or stabilized the bright red induction, but a uv phase had no effect on this antagonism if given before the bright red-dark red phases. The length and cross sections of achaenia showed that the cortical layers were intensely pigmented so that it could be assumed as likely that uv was not able to penetrate to the receptors. Because of the relatively great disparity in the materials used and the small latitude for response (latitude between a maximum reaction and the reaction after optimal obliteration of induction) probably even the Triticum and Lactuca material selected was unsuitable for a thorough causal analysis. (BBB)

20437 THE OXYGEN EFFECT FOR ACUTE AND PROTRACTED RADIATION EXPOSURES MEASURED WITH SEEDLINGS OF VICIA FABA. Hall, Eric J.; Cavanagh, Josephine (Churchill Hospital, Oxford). Brit. J. Radiol., 40: 128-33(Feb. 1967).

Seedlings of Vicia faba were used to measure the oxygen enhancement ratio (O.E.R.) for acute x-ray and protracted γ-ray exposures at 3°C and 19°C. At 3°C there was no significant difference between the O.E.R. for acute or protracted exposures (2.67 and 2.70 respectively). At 19°C the O.E.R. was significantly lower for protracted than for acute exposures (2.06 compared with 2.58). There was found to be no recovery between split-doses delivered under hypoxic conditions in contrast to the marked recovery that takes place when the irradiation is carried out under conditions of normal aeration. (auth)

20438 SOME ASPECTS OF THE RADIOBIOLOGY OF CHLOROPHYLLIC MICROORGANISMS. Ozenda, Paul (Centre d'Etudes Nucleaires, Grenoble, France). pp 341-66 of Travaux Dedies a Lucien Plantefol. Paris, Masson et Cie, 1965. (In French).

The principal results obtained since 1958 in the study of the radiobiology of Scenedesmus crassus, Chlorella vulgaris, and Chlorella pyrenoidosa were reported. The growth of the populations of cultures of Scenedesmus after x irradiation at various doses were determined. The 100% lethal dose varies between 70 and 100 kr for the different species. The growth under x-irradiation was analyzed at the cellular level. A comparative study was made of the radiosensitivity of Scenedesmus and Chlorella. The growth curve after irradiation was comparable but showed a slightly lower radioresistence in Scenedesmus. The comparison was made of the relative biological efficiency of gamma, x, and ultraviolet radiation. The dose-time relation was studied. The ratio of survival as a function of the number of fractionated doses and the total time of rest between fractions showed that restoration seemed to increase with the spacing of the fraction and the restoration seemed to increase slightly with the number of frac-

tions. Initial studies were made on the effect of the physiological state during radiation and the cytophysiological effects of irradiation. (J.S.R.)

20439 POLLEN RADIOSENSITIVITY WITH REGARD TO FRUIT AND SEED FORMATION. Vassileva-Dryanovska, O. A. (Agricultural Coll. of Sweden, Uppsala. Dept. of Genetics, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 759-62(1966).

Pollen was x irradiated at 1,000 to 500,000 R immediately before pollination of plants with varying genetic background. With increasing dose, seed reduction, but not fruit reduction, occurred. In the case of pollen with relatively large and equal generative nuclei and chromosomes, the one with the smaller number of chromosomes is more radiosensitive than that with a greater number of chromosomes. Pollen with equal chromosome number, but larger generative nuclei and chromosomes, is more radiosensitive. Pollen of early prophase is more radiosensitive than late prophase or pollen in a stage of two sperms. A table summarizes data on fruit and seed formation with the different doses of radiation for the following plants: Tradescantia paludosa, Lilium speciosum, Lycopersicum esculentum, Solanum melongena, Ornithogalum graminifolium, and Melandrium rubrum. (C.O.)

Radiation Effects on Microorganisms

Refer also to abstracts 20123, 20124, 20284, 20288, and 20425.

20440 (TID-23502) REPORT OF THE WORK ACCOMPLISHED DURING THE PERIOD DECEMBER 15, 1964 TO DECEMBER 15, 1966 [ON EFFECT OF RADIATION ON SYNTHESIS ON DNA]. (Institut Pasteur, Paris (France)). Contract AT(30-1)-2803. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

New origins of transfer of genetic determinants in Escherichia coli K12 were induced by radiation. X rays, uv radiation, α particles, and ^{32}P induce some Hfr strains of E. coli to transfer their genetic determinants, during mating, in a direction differing from the normal. The production of these invertants by radiation occurs independently of the site of the normal origin of transfer and of the direction of this process. The same invertant strain is produced from several Hfr strains differing with respect to their origins and directions of transfer by radiation. Studies were conducted to determine the location on the genetic map of the origin of vegetative replication of the chromosome of E. coli Hfr cells. It was shown that the vegetative origin of replication is located half way on the chromosome from the markers Pur E, Pro C, where the origin of transfer lies. During these experiments it was confirmed that in E. coli K12 thymine starvation initiates a premature cycle of replication at the normal site before completion of the previous one. The role of DNA synthesis in the transfer of genetic markers was studied by using ^{3}H-5-bromodeoxyuridine and DNA extracted and banded in a cesium chloride density gradient. A study of the enzymes involved in regulation of chromosome replication was carried out using strains with mutations in their regulation of DNA synthesis. Radioresistant mutants induced by radiation in Saccharomyces cerevisiae were studied. The ability to induce abnormal segregations after meiosis, a character which had been induced, together with a radioresistant mutant, in haploid cells by ^{32}P, was studied more thoroughly. This character was expressed by a high frequency of prototrophic asci. The analysis of the sporulating capacity, the stability, and the DNA content of the monosporic clones derived from these asci, suggested that an extraduplication of the genetic material during meiosis might account for their behavior. (H.L.W.)

20441 FACTORS INFLUENCING RADIOPROTECTION AND RESTORATION IN YEAST CELLS. Maisin, J.; van Duyse, E.; Dunjic, A. (Institut du Cancer, Louvain). Rev. Franc. Etud., Clin. Biol., 12: 63-8(Jan. 1967). (In French).

It has been demonstrated previously that ribonucleic acid and its nucleotides when added to culture medium improve the survival of yeast cells after exposure to lethal dosages of x rays. The different factors which influence the restoration action of ribonucleic acid and its nucleotides were studied: two strains of yeast, a resistant strain and a sensitive one; different origins of yeast ribonucleic preparations, the concentrations of ribonucleic acid in the medium and the factors present in the degradation products after alkaline hydrolysis of RNA. The time of 120 mn and the concentration-response relationships of 2.6×10^{-2}M were determined for the protection action of MEA. The conclusions are: (a) RNA and the hydrolyzed products improved the restoration effect of Saccharomyces cerevisiae; (b) single nucleotides of RNA and the 4 nucleotides together incorporated in the medium are without any effect on the restoration process; and (c) RNA and MEA exert under defined experimental conditions real protective action against radiation lesions of Saccharomyces cerevisiae. (auth)

20442 RELEASE OF INORGANIC PHOSPHATE FROM IRRADIATED YEAST: RADIATION BIODOSIMETRY AND EVALUATION OF RADIOPROTECTIVE COMPOUNDS. Levinson, Hillel S.; Garber, Esther B. (Army Natick Labs., Natick, Mass.). Appl. Microbiol., 15: 431-40(Mar. 1967).

When cells of bakers' yeast, Saccharomyces cerevisiae, were irradiated with γ radiation, inorganic phosphate, ninhydrin-reactive material, and substances absorbing at 260 mμ were released into the suspending medium. The amount of inorganic phosphate released depended on the radiation dose and on the temperature and pH during irradiation. The concentration of yeast cells did not affect the phosphate yield per milligram of yeast. It is suggested that the release of phosphate may serve as an index of the total radiation environment (i.e., as a biodosimeter) where radiation inactivation of microorganisms is of primary importance, e.g., in radiation preservation of foods. The somewhat limited range of the yeast biodosimeter (ca. 0.5 to 1.75 Mrad) may be extended by use of other more resistant microorganisms, such as bacterial spores. Compounds which have been reported as protecting microorganisms and mammals against the lethal effect of ionizing radiation also inhibited the radiation-induced release of inorganic-phosphate for yeast. This phosphate release system is proposed as the basis for an economical, rapid supplement to screening procedures in the evaluation of radioprotective compounds. (auth)

20443 ON THE MECHANISM OF INDUCTION OF INTRACELLULAR DEVELOPMENT OF BACTERIOPHAGE LAMBDA BY MUTAGENS OF VARIOUS NATURE. Guberniev, M. A.; Kolobov, A. V.; Ryabakov, N. I. (Inst. of Experimental Biology, Moscow). Genetika, No. 3, 161-70(Mar. 1967). (In Russian).

The results are presented of a comparative study of the activity of mutagenic factors of various nature causing bacteriophage induction in lysogenic bacteria. It was shown that the ionizing radiation (protons of high energy, x and γ rays of ^{60}Co), non-ionizing radiation (ultraviolet rays), as well as mitomycin C, caused the same type of phage-producing reaction in a lysogenic strain of E. coli K-12. The data on the ability of the crystalline deoxyribonuclease to induce the temporary bacteriophage in the lysogenous culture of E. coli K-12 treated with this enzyme are presented in this paper. At the same time it was shown that various inhibitors of the intracellular deoxyribonuclease suppress to a considerable extent the phage induction caused by the activity of the abovementioned mutagenic factors. On the basis of these results it is assumed that the primary mechanism of the phage induction is associated to some extent with an indirect effect of radiation or other inducing agents by means of the intracellular deoxyribonuclease activation that can cause some confusion in the groups of triplets coding the information on the repressor synthesis. (auth)

20444 INFLUENCE OF CULTURE MEDIA ON THE RADIATION RESISTANCE OF MICROCOCCUS RADIODURANS. Krabbenhoft, K. L.; Anderson, A. W.; Elliker, P. R. (Oregon State Univ., Corvallis). Appl. Microbiol., 15: 178-85(Jan. 1967).

The addition of NZ-case (a tryptic digest of casein) to a growth medium (PC) consisting of tryptone, glucose, and yeast extract caused a significant decrease in γ radiation resistance of Micrococcus radiodurans. The level of radiation resistance was inversely related to the concentration of NZ-case. The LD_{50} for this organism was approximately 700 krad when grown in tryptone, glucose, yeast extract, and DL-methionine (TGYM) broth, but it was approximately one-half as resistant when grown in a PC medium containing 0.5% NZ-case (PCNZ). The resistance to ultraviolet light was also reduced. Cultures transferred from PCNZ to TGYM media regained the high level of resistance. (auth)

20445 THE INTERACTION BETWEEN ULTRA-VIOLET AND GAMMA IRRADIATION IN ASPERGILLUS NIDULANS. Arlett, C. F. (Atomic Energy Research Establishment, Wantage, Eng.). Int. J. Radiat. Biol., 11: 313-20(1966).

Interaction between ultra-violet and gamma irradiation for survival was observed with Aspergillus nidulans. It was suggested that this interaction provided a demonstration of repair mechanisms in this organism. In contrast to previous reports no interaction was observed in mutation induction for resistance to 8 aza-guanine or 6-methyl purine. (auth)

20446 EFFECTS OF IONIZING RADIATION ON FREE AMINO ACIDS IN OEDOGONIUM CARDIACUM. Banerjee, M.; Banerjee, S. N.; Horsley, R. J. (Ontario Cancer Foundation, Hamilton). Int. J. Radiat. Biol., 11: 395-7(1966).

The concentrations of 10 amino acids found in this filamentous alga were determined before and after irradiation of 8000 rads ^{60}Co. At two hours post-irradiation, about 15% of the total filament concentration had leaked into the medium. This represented a maximum, with the exception of leucine, which peaked at one hour. At the two-hour period, the total concentration of amino acids in

the filaments increased by a factor of 1.5. This increase occurred while the cells were deprived of exogenous metabolites, suggesting that it may be due to the breakdown of some of the cell protein. (C.O.)

20447 RADIOSENSITIZATION OF YEASTS BY DIETHYLPROCARBONATE. Dupuy, P.; Tremeau, O. (Institut National de la Recherche Agronomique Station de Technologie Vegetale, Versailles, France). Int. J. Appl. Radiat. Isotop., 18: 253-9(Apr. 1967). (In French).

Diethylpyrocarbonate (DEPC) sensitizes budding yeasts as well as yeasts without buds to the lethal action of γ radiation. This compound is very unstable, it hydrolyses spontaneously, its half-life is about 30 min at 0°C, and its destruction is much faster under irradiation. Its action on the yeasts is different from that of iodoacetamide and sulfurous acid which are also sensitizers. Thus, its efficiency is not hindered by the presence of sugars, and it does not produce a post-effect. According to the already known properties of DEPC, the sensitization does not appear caused by a reaction with nuclei acids, but more likely by an inhibition of enzymes through combination with thiol groups. (UK)

20448 INVESTIGATIONS OF THE EFFECT OF BETA RAYS ON DERMATOPHYTES. Meinhof, W.; Wiskemann, A. (Univ., Marburg-Lahn, Ger.). Arch. Klin. Exp. Dermatol., 223: 185-98(Sept. 1, 1965). (In German).

Trichophyton mentagrophytes, Microsporum gypseum, Epidermophyton floccosum, and Keratinomyces ajelleo in agar were irradiated with a $^{90}Sr-^{90}Y$ source. The cultures had a diameter of about 10 μ and were completely irradiated. Spores of these organisms were also irradiated in either extremely dry or extremely wet environmental conditions. The irradiator was located at a distance of 6.5 mm or 3 mm. With a 10-mCi irradiator the dose rate was 3080 and 5600 rad/hr, respectively, and with a 50-mCi irradiator, the dose rates administered were 18,700 and 32,500 rad/hr. The lethal doses found ranged between 4×10^5 and 10^6 rad. For T. mentagrophytes cultures and spores the lethal dose was 6×10^5 rad. K. ajelloi and M. gypseum cultures survived greater amounts of irradiation from the 50-mCi source than from the 10-mCi source. For K. ajelloi the lethal dose increased from 7×10^5 to 1.04×10^6 rad. The radiosensitivity of K. ajelloi spores was increased in both dry and moist environments. E. floccosum spores in dry state were destroyed with 3×10^5 rad. Dry M. gypseum and K. ajelloi spores were killed at 4.5×10^5 rad, but T. mentagrophytes spores were completely destroyed at 6×10^5 rad. With the exception of M. gypseum, after irradiation with sublethal doses, the germination of the spores was delayed in proportion to the total dose and dose rate. The final velocity of the rate of growth was not affected by irradiation. (BBB)

20449 THE EFFECTS OF HOST-CELL REACTIVATION ON ASSAY OF U.V.-IRRADIATED HAEMOPHILUS INFLUENZAE TRANSFORMING DNA. Patrick, M. H.; Rupert, C. S. (Southwest Center for Advanced Studies, Dallas). Photochem. Photobiol., 6: 1-20(Jan. 1967).

The host cell reactivation (HCR) mechanism in Haemophilus influenzae cells was inhibited by sub-microgram concentrations of acriflavin, as previously found with Escherichia coli. Exposure of these cells to similar concentrations of the drug during bacterial transformation increased the apparent uv light sensitivity of previously irradiated transforming DNA, indicating a repair of this DNA after uptake by the cells under normal conditions. Repair was inhibited by applying acriflavin at any time up to 1 hr after competent cells contact the irradiated transforming DNA. The fraction of the uv damage repaired by HCR was different for different genetic markers. Markers which are most uv sensitive when assayed in the absence of acriflavine are most poorly repaired, suggesting that this is the reason for their higher sensitivity. For all markers the fraction of the damage repairable by in vitro photoreactivation was constant and strongly overlapped the damage repairable by HCR. The degree of HCR achieved could be altered by experimental treatment of the H. influenzae DNA prior to transformation. Thus treatment of irradiated DNA with an enzyme from Micrococcus lysodeikticus (known to attack uv-damaged, but not undamaged DNA) prevented subsequent intracellular repair of the same uv lesions whose repair was inhibited by acriflavin. Similarly, partial replacement of the thymine in transforming DNA by 5-bromouracil (BU) strongly inhibited repair of subsequent uv damage. The BU effect was relieved if the uv exposure occurred in the presence of cysteamine. Intracellular repair must be considered in interpreting experiments with uv-irradiated transforming DNA. (BBB)

20450 RADIATION-INDUCED LETHAL SECTORING IN YEAST. James, A. P.; Werner, M. M. (Chalk River Nuclear Labs., Ont.). Radiat. Res., 29: 523-36(Dec. 1966).

Pedigree analyses of x-irradiated diploid yeast cells have shown that clones produced by surviving cells frequently contain subclones, the cells of which are incapable of further division. This phenomenon, termed lethal sectoring, was found in a series of experiments to be more common than lethal damage leading to outright killing or to death of all progeny of an irradiated cell. The number of moribund cells within a lethal sector was variable. These cells appeared to represent residual growth following the occurrence of a prelethal event in a progenitor cell. Progenitor cells originated in any of the four postirradiation generations assayed. The distribution of lethal sectors within developing colonies showed that some colonies were more prone to sectoring than others; the likelihood that a cell would initiate a lethal sector decreased as that cell was further removed, by lineage, from the irradiated cell; the likelihood that the original irradiated cell would initiate a lethal sector in a given generation decreased through successive generations; within any generation, daughter cells were more prone to initiate sectors than were mother cells. There was no evidence that risk of sectoring differed in the two main lines of descent within a pedigree. Various mechanisms by which x-ray-induced damage might cause lethal sectoring were considered. These included immediate genetic change, delayed mutation, and extrachromosomal damage. It was concluded that the present data point to extrachromosomal damage as the major cause. (auth)

20451 NEW RADIOMODIFIERS IN BACTERIA. Pittillo, Robert F.; Lucas, Mary B.; Bannister, Edward R. (Southern Research Inst., Birmingham, Ala.). Contract PH43-62-485. Radiat. Res., 29: 549-67(Dec. 1966).

Representatives of three classes of chemical compounds previously not noted as radiomodifiers have been found to exert radiosensitizing effects in bacteria, especially Escherichia coli. The three classes of compounds represented are: phthalanilides, phenaziniums, and isoindoliniums. The mechanisms by which these compounds exert their radiosensitizing effects are not known. (auth)

20452 EFFECT OF TEMPERATURE ON RADIATION RESISTANCE OF SPORES OF CLOSTRIDIUM BOTULINUM 33A. Grecz, N.; Upadhyay, J.; Tang, T. C. (Illinois Inst. of Tech., Chicago). Can. J. Microbiol., 13: 287-93(Mar. 1967).

Spores of Clostridium botulinum 33A in two suspending media, phosphate buffer and pork pea broth, were gamma irradiated at radiation temperatures from +20°C to −196°C. The liquid-solid transition around 0°C introduced a one-step plateau-like change in radiation sensitivity of spores. The spores were considerably more resistant in the solidly frozen medium than in the liquid medium. The solid state reduced indirect effects of radiation by physical blocking of secondary radicals. The one-step transition was much smaller in pork pea broth than in buffer. This indicated that scavenging of secondary radicals by pork pea broth caused a considerable reduction of indirect effects of radiation, but did not completely eliminate them. Freezing alone did not eliminate all indirect effects. This was evident from the gradual reduction in radiation sensitivity of spores in the solidly frozen phosphate buffer between −25°C and −196°C. Furthermore, even at −196°C indirect effects of radiation remained active since (a) spore survival did not level off with respect to temperature and (b) the lethal efficiency of radiation was still appreciably greater in phosphate buffer than in pork pea broth at −196°C. In frozen pork pea broth at −25°C to −196°C temperature had no effect on radiation sensitivity of spores. This indicated that spores were killed by direct hits; apparently physical blocking by the solidly frozen medium, plus radical scavenging by pork pea broth eliminated all indirect effects of radiation. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 19853 and 20384.

20453 (AECD-RB-1) PAEC-CSIR JOINT PROJECT ON RICE IRRADIATION: TASTE PANEL REPORT ON ORGANOLEPTIC TESTS. Hossain, M. M.; De, H. N.; Choudhury, S. U.; Nabi, N. (Atomic Energy Centre, Dacca (Pakistan). Radiobiology Div.). May 1966. 8p. Dep. mn.

Exposure of stored rice to a dose of 16,000 R of ^{60}Co γ radiation was found to kill insect pests and their eggs. Results are reported from a taste-panel evaluation of the flavor, texture, taste, and color of cooked irradiated and control rice. It was concluded that radiation treatment causes no undesirable changes in the organoleptic properties of rice. (C.H.)

20454 (NYO-3499-2) STABILITY OF FOOD LIPIDS TO IONIZING RADIATION. Progress Report, September 1, 1965-

October 31, 1966. Nawar, W. W.; Dubravcic, M.; Champagne, J. R. (Massachusetts Univ., Amherst. Dept. of Food Science and Technology). Nov. 1966. Contract AT(30-1)-3499. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Fats were extracted from mackerel, pork, and beef. Samples were sealed under vacuum in glass tubes and irradiated using a cobalt-60 source. Volatiles were collected from irradiated and unirradiated fats. Identification of volatile components was carried out by means of gas chromatography and mass spectrometry. The unirradiated fats from beef and pork were practically free from volatiles. The major components formed by irradiation consisted of a homologous series of saturated and unsaturated hydrocarbons. The fresh unirradiated fish oil gave a complex chromatographic pattern of volatiles. Irradiation caused an increase in the same hydrocarbons as those in beef and pork as well as changes in other components. The homologous series formed by irradiation in the beef, pork, and fish fats were the C_7 to C_{16} alkanes and alkenes. The unirradiated mackerel oil contained pristane; irradiation caused a slight destruction of this compound. Organoleptic studies indicated that alkenes were much stronger odorants than alkanes. The effect of irradiation on the oxidation of fish oil was investigated by oxygen absorption, peroxide value, and organoleptic evaluation. (H.L.W.)

20455 (ORO-3097-9) EFFECTS OF LOW LEVEL IRRADIATION UPON THE PRESERVATION OF FOOD PRODUCTS. Progress Report. (Florida Agricultural Experiment Station, Gainesville). Feb. 1, 1967. Contract AT(40-1)-3097. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The feasibility of radiopreservation of fruits was studied in citrus fruits (pineapples, oranges, tangerines, grapefruit, and lemons), peaches, strawberries, and mangoes. Parameters of irradiated fruits such as external color, peel injury, ascorbic acid content, and organoleptic qualities were evaluated. Citrus fruits subjected to radiation levels above 200 krad were rated less acceptable in flavor after short-term (7 to 10 days) storage. There were no serious objections to any of the quality attributes of the irradiated citrus fruits. Irradiated mango fruit were less firm than controls, but fruit softness because of ripening was more pronounced than softness induced by irradiation. There were no differences in the organoleptic qualities of irradiated and nonirradiated mangoes. In irradiated peaches a loss of anthocyanin content was noted immediately following exposure, ascorbic acid losses of 6 to 10% were induced by 100 and 150 krad dosages, and exposure at advanced stages of ripening resulted in a more organoleptically-acceptable product. Irradiation of strawberries at the white shoulder to pink ripe stage resulted in retention of a higher percentage of sound berries than irradiation at an advanced stage of ripeness, and in general the incidence of Botrytis and Rhizopus infections were reduced considerably by irradiation with 200 krad doses, an effect that was independent of stage of ripening at exposure. (H.G.D.)

20456 (RISO-140) THE BASIS OF THE DANISH CHOICE OF DOSE FOR RADIATION STERILIZATION OF DISPOSABLE EQUIPMENT. Christensen, Ebbe Ahrensburg (Statens Seruminstitut, Copenhagen (Denmark)); Holm, Niels W.; Juul, Flemming (Danish Atomic Energy Commission, Risoe. Research Establishment). Sept. 1966. 18p. Dep. mn.

This report describes the basis of radiation sterilization of medical utensils in Denmark and of the choice of dose for sterilization at Risö of disposable equipment of dry plastic. The possibilities of establishing general criteria for efficient sterilization by comparison with autoclaving are dealt with. A description is given of the selection of test strains and test pieces for use in fixing the dose for sterilization of a particular category of utensils and in controlling the microbiological effect of the irradiation. The possibilities of continuous control of disposable equipment based on counting of the micro-organisms present on the equipment prior to irradiation are discussed. Such day-to-day control must be assumed to warrant a reduction of the routine dose below the minimum of 4.5 Mrad used in Denmark for dry plastic equipment. (auth)

20457 (RLO-1730-5) IRRADIATION PASTEURIZATION OF SEAFOODS. Annual Progress Report, October 1, 1965-October 30, 1966. Dollar, Alexander M.; Liston, J.; Matches, J. R. (Washington Univ., Seattle. Coll. of Fisheries). Contract AT(45-1)-1549/1730. 98p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Radiation reduces the total count of flora in fillets prepared from fish immediately after catching to a level below accurate detection. This reduction is true to a lesser degree for samples taken from fish held in ice storage for up to 12 days. It is important to note that the storage life of fish irradiated in an absolutely fresh condition is greatly in excess of fish irradiated after ice storage for even as short a period as 4 days. Irradiation largely eliminates organisms producing high amounts of total volatile base (TVB). Changing the environment such as the type of packaging and the degree of vacuum produced alters the biochemical processes during storage at 34°F. Incidence of bacteria reducing TMAO or yielding TVB is consistently low in irradiated fish. Since these biochemical activities yield products typical of spoiled fish, their repression provides a partial explanation for the extension of shelf life that results from the irradiation treatment. Studies clearly show that packing in helium, or complete evacuation of the product, prevents development of rancidity and oxidation of fish products while, in contrast, an atmosphere of nitrogen or air encourages the development of rancidity. This rancidity develops even when the nitrogen and the product are kept in separate containers and combined only after exposure to radiation. These results confirm the necessity of irradiating fisheries products in an evacuated container to ensure the best quality. Studies with model systems and tissues demonstrated that irradiation of glucose and other sugars, with phosphate buffers, yields products that will brown when heated. The glucose oxidase system and the horseradish peroxidase o-dianisidine system are very sensitive to peroxide. This enzyme method confirms that peroxide forms and persists during storage when simple model systems of a carbohydrate dissolved in a phosphate buffer are exposed to 50 kR or more of gamma radiation. Catalase, an enzyme in tissues that destroys peroxides, is inactivated when irradiated (less than 100 kR) in simple model systems and is partially protected in tissues. It is probable that catalase can serve to indicate that animal and fish tissues have been exposed to radiation. Catalase is essential to protect the fish tissue from oxidative damage due to peroxides. Heating fish tissue before radiation inactivates the catalase and peroxides formed in the product are not destroyed. Hence good results are observed when the very fresh products are irradiated and, since cooking destroys catalase, more care is necessary in the irradiation pasteurization of cooked shellfish such as crab. (auth)

20458 QUALITY EVALUATION OF IRRADIATED PAKISTANI RICE. Tape, Norman W.; Ferguson, W. E. (Food Research Inst., Ottawa). Food Irradiat., A22-A25(July-Dec. 1966).

Data are given on the effects of gamma radiation on control of insects on rice. The rice was packaged in 4 lb lots in polyethylene bags. Several 4 lb samples were irradiated by the Atomic Energy of Canada Ltd. in a Gammacell 220 (^{60}Co gamma radiation at a rate of approximately 1.3 million rads per hour). Samples were exposed to 15,000 rads, 30,000, and 60,000 rads. This range was selected because of the approved dose range for wheat in the United States and the results of Watters. The latter found that no progeny of six common grain infesting insects were obtained from adults irradiated in wheat at 12,500 rads or higher. Sensory and objective tests were conducted in the Food Research Institute to determine if differences in quality existed between the control and irradiated rice. Vitamin assays were made in the Food and Drug Directorate (Department of National Health and Welfare). The irradiation of rice to control insect infestation does not have any effect on rice quality. The flavor, texture, and color of rice was not affected by 30,000 rads. Some indication of a harmful effect on flavor was observed in rice irradiated with 60,000 rads. However, this dose level is more than that required for insect control. The niacin and thiamine content was not changed by irradiation. (auth)

20459 NINETY DAY RAT FEEDING STUDY ON IRRADIATED STRAWBERRIES. Verschuuren, H. G. (National Inst. of Public Health, Utrecht); Van Esch, G. J.; Van Kooy, J. G. Food Irradiat., 7: No. 1-2, A17-A21(July-Dec. 1967).

Over a period of 12 weeks Wistar rats received strawberries that were nonirradiated or irradiated with 500 and 5,000 krad respectively. In one experiment the strawberries were given as a 5% strawberry-powder in the diet; in the other experiment as "strawberry-juice" by stomach tube. The male rats which received strawberry-powder irradiated with 5,000 krad showed a statistically significant growth retardation. There appears to be no reasonable explanation for this abnormality. The corresponding female rats receiving the same powder and rats of both sexes receiving the juice irradiated with 5,000 krad showed no significant effects. No obvious influence on the blood composition could be discovered in the different groups. Histopathological investigation of the organs did not show abnormalities which could be connected with the administration of the irradiated strawberries. It has been clearly demonstrated that the animals, which received strawberries irradiated with 500 krad, did not show any kind of toxic effects. These results show that the preservation of strawberries by irradiation is biologically acceptable and seems therefore to be promising. It might, however, still be necessary to carry out chronic toxicity experiments. The next step to be investigated before commercialization is whether this process is

economically viable. Data on the economics will become available from pilot plant work in the Netherlands during 1968. (auth)

20460 COMPARATIVE EFFECTS OF CHLORTETRACYCLINE, FREEZING, AND γ RADIATION ON MICROBIAL POPULATION OF OCEAN PERCH. Lee, J. S.; Willett, Crystal L.; Robison, Sarah M.; Sinnhuber, R. O. (Oregon State Univ., Corvallis). Appl. Microbiol., 15: 368-72(Mar. 1967).

The microbial populations in chlortetracycline (CTC)-treated (50, 100, 200, and 500 ppM), frozen (–15°C), and γ-irradiated (0.1 Mrad) ocean perch (Sebastodes alutus) were compared. The control sample spoiled at 7°C, primarily because of the growth of Pseudomonas. Irradiation changed this to Achromobacter-dominated spoilage. Freezing or CTC treatment altered the spoilage pattern very little. CTC was particularly effective against ultraviolet fluorescent Pseudomonas species at the higher concentrations. Freezing and CTC were not effective against coryneform bacteria. (auth)

20461 CHANGES IN THE MICROFLORA OF IRRADIATED PETRALE SOLE (EOPSETTA JORDANI) FILLETS STORED AEROBICALLY AT 0.5 C. Pelroy, Gretchen A.; Seman, John P. Jr.; Eklund, Melvin W. (Bureau of Commercial Fisheries, Seattle). Appl. Microbiol., 15: 92-6(Jan. 1967).

The microfloral changes on irradiated petrale sole fillets during aerobic (packaged with oxygen-permeable film) refrigerated storage were determined by the identification of bacterial and yeast isolates to the generic level. The samples were irradiated at 0.0, 0.1, 0.15, 0.2, 0.3, and 0.4 Mrad by use of a cobalt-60 gamma source, were stored at 0.5 C, and were examined periodically for spoilage, total microbial population, and composition. The preirradiation flora of the fresh fillets consisted of coryneforms, Achromobacter, Micrococcus, Flavobacterium, Pseudomonas, and Lactobacillus. Immediately after irradiation, Micrococcus, Achromobacter, coryneforms, and Bacillus were predominant. The flora of the nonirradiated fillets at the time of spoilage consisted of Achromobacter and Trichosporon. (auth)

20462 RADIATION STERILIZATION OF PROTOTYPE MILITARY FOODS. II. CURED HAM. Anellis, Abe; Berkowitz, D.; Jarboe, C.; El-Bisi, H. M. (Army Natick Labs., Mass.). Appl. Microbiol., 15: 166-77(Jan. 1967).

Ten lots of diced cured ham, packed in cans, were inoculated with approximately 10^6 Clostridium botulinum spores per can. Each lot was seeded with a different strain (five type A and five type B strains). All cans were irradiated to various dose levels with ^{60}Co. Evidence provided by swelling, toxicity, and recoverable C. botulinum with 6,350 cans demonstrated that: (i) 4.5 Mrad was more than adequate as a sterilization dose; (ii) the minimal experimental sterilizing dose (ESD) based on nonswollen nontoxic endpoints was $2.0 < ESD \leq 2.5$ Mrad, and based on nonspoiled sterile cans was $3.0 < ESD \leq 3.5$ Mrad (the latter was supported by the computed theoretical 12D dose); (iii) D values calculated from botulinal survival data indicated that, as a group, the type A strains were more radioresistant than type B strains: strains 12885A and 41B, with respective D values of 0.242 and 0.175, represented the most resistant of each type; (iv) swollen cans did not always contain toxin, nor were toxic cans always swollen; (v) viable C. botulinum can exist for 6 months at 30 C without producing visible or toxic spoilage at doses of 3.0 Mrad and lower, including, in some instances, 0.0 Mrad; and (vi) a phenomenon similar to heat activation of spores occurred at sublethal radiation doses. (auth)

20463 BIOLOGY AND RADIATION STERILIZATION OF SUGAR CANE LEAFHOPPERS. Osborn, A. W. (Univ. of New South Wales, Kensington); Shipp, E.; Hutchinson, P. B. At. Energy Austral., 9: No. 4, 11-19(Oct. 1966).

An important disease of sugar cane in the Pacific areas is Fiji disease which is caused by a virus transmitted by leafhoppers, Perkinsiella spp. The possibility of eradicating leafhoppers by repeated releases of sterile insects was investigated. Several varieties of sugar cane were tested for suitability for mass-rearing experiments. Studies were conducted on the effects of nitrogenous fertilizer on fecundity of leafhoppers and on the most suitable temperature for mass-rearing of Perkinsiella saccharicida. Nymphal instars were irradiated with cobalt-60 to obtain sterility while maintaining mating competitiveness. Natural population fluctuations were studied in Australia and in Fiji. The most important factors influencing populations were rainfall, temperature, nitrogen content of sugar cane leaves, and egg-predator, Cyrtorhinus mundulus. Results at present indicate that a successful sterile insect release program can be carried out economically on sugar cane leafhoppers. (H.L.W.)

20464 THE TECHNICAL BASIS FOR LEGISLATION ON IRRADIATED FOOD. Report of a Joint FAO/IAEA/WHO Expert Committee, Rome, 21–28 April 1964. World Health Organ., Tech. Rep. Ser., No. 316, 1-56(1966).

This committee considered available evidence on the effects on food of treatment with ionizing radiation and made recommendations on the general principles under which the production and use of irradiated food may be permitted and the procedures that should be adopted for the evaluation of the wholesomeness of irradiated food. Committee personnel included experts in food technology, packaging, biochemistry, microbiology, public health, pharmacology, toxicology and radiation technology. (C.O.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

20465 REACTOR MATERIALS. Volume 9, Number 4. Simons, E. M.; Porembka, S. W. Jr.; Keller, D. L. (eds.). A Quarterly Technical Progress Review published for the Division of Technical Information, USAEC. Columbus, Ohio, Battelle Memorial Inst., Winter 1966–1967. 90p. GPO $0.70 Domestic, $0.90 Foreign.

Recent developments in research concerning reactor materials are reviewed. The review is divided into five sections. Separate abstracts were prepared for each section. (B.L.M.)

For abstracts of individual sections see: 20466–20469 and 20484.

20466 FUEL AND FERTILE MATERIALS. Reactor Mater., 9: 203-16(Winter 1966–1967).

Recent developments in research on reactor fuels and fertile materials are reviewed. 72 references are cited. (B.L.M.)

20467 MODERATOR MATERIALS. Reactor Mater., 9: 217-25(Winter 1966–1967).

Recent developments in research on reactor moderator materials are reviewed. 19 references are cited. (B.L.M.)

20468 NUCLEAR POISONS. Reactor Mater., 9: 226-8 (Winter 1966–1967).

Recent research developments in nuclear poisons are reviewed. 8 references are cited. (B.L.M.)

20469 CLADDING AND STRUCTURAL MATERIALS. Reactor Mater., 9: 229-54(Winter 1966–1967).

Recent research developments in cladding and structural materials for reactors are reviewed. 104 references are cited. (B.L.M.)

Corrosion and Erosion

20470 (EURAEC–1796) STUDIES OF STEEL CORROSION IN HIGH TEMPERATURE WATER AND STEAM. Quarterly Report No. 17, October 1, 1966–December 31, 1966. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). Contract 087-1-TEEB(RD). 112p. (EUR–3336). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Developments in studies on corrosion of steels and other alloys by steam and water at high temperatures are reported. The materials studied included: stainless steel; steel; Zircaloy-2; Fe–Cr–Zr alloy; Inconel 600; and Incoloy 800. With regard to AISI Type-304 stainless steel, it was confirmed that excellent long-term behavior in superheated steam at 500°C calls for work-hardening to a depth of several tens of microns, such as may be produced by turning or milling. Tests in steam at 500°C for 500 hr with 20 ppM added showed that the work-hardened surface was not significantly affected. The grain size of recrystallized stainless steels had some influence on their behavior in superheated steam. Microscopic examination of Inconel 600 and Incoloy 800 specimens oxidized in autoclaves in superheated steam at 600 and 700°C revealed very marked intergranular corrosion in the case of Inconel 600. Tests on a Zr–Cr–Fe alloy in superheated steam at 450°C showed that, after 3,000 hrs, electrolytic polishing is more favorable than pickling or preparing the surfaces mechanically. This advantage appears to be connected with transition point stagger. (P.C.H.)

20471 (NASA-CR–54844) STUDIES OF ALKALI METAL CORROSION ON MATERIALS FOR ADVANCED SPACE POWER SYSTEMS. Quarterly Progress Report No. 5, June 26, 1965–September 26, 1965. Harrison, R. W. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). Contract NAS3-6012. 23p.

The D-43 Alloy Stress Corrosion Reflux Capsule Test I completed 1000 hours of testing at a nominal temperature of 2100°F and was removed from the test facility. Equivalent uniaxial creep strains of 7.4% in the liquid region and 5.4% in the condensing region were calculated from the expansion data. The capsule was drained of K, cleaned, and sectioned. Although examination of the inner surface of the capsule revealed the presence of spots in the liquid and condensing regions, further investigations indicated no association between the location of the spots and the regions of high stress. Lower uniaxial creep strengths were obtained from capsule test data than were predicted by pretest and literature data. Additional uniaxial creep tests are planned in expectation of explaining this anomaly. The D-43 Alloy Stress Corrosion Reflux Capsule Test II continues on test at a nominal temperature of 2050°F. A total of 1600 hours of test time has been accumulated. (auth)

20472 (NASA-CR–72146) SNAP-8 MATERIALS REPORT FOR JULY–DECEMBER 1965. Derow, H.; Farwell, B. E. (Aerojet-General Corp., Azusa, Calif.). Feb. 1966. Contract NAS5-417. 90p.

Materials work that provided data to guide the selection of materials for SNAP-8 system components is presented. Tests included evaluation of materials and components for the NaK heaters and primary loop, boilers, and turbine. The mechanical properties of Stellite 6B (a Co-base alloy) were investigated for use as the reference SNAP-8 turbine rotor and nozzle material. Various alloys considered as potential SNAP-8 turbine materials were exposed at elevated temperatures for a preliminary evaluation of their metallurgical stability. After completion of a test series in RPL-2, the tube-in-shell -1 boiler was removed from material evaluation. The NaK side operated for 2350 hr and the Hg side for 1415 hr. The corrosion and mass-transfer patterns in the Hg and NaK loops of the SNAP-8 system were determined, and the corrosion resistance of the SNAP-8 reference materials were evaluated with regard to the 10,000 hr life requirement. Also, the corrosion loops were used to investigate mercury boiler heat-transfer characteristics. (P.C.H.)

20473 (NASA-CR–72156) SNAP-8 MATERIALS, Semiannual Report, January–June 1966. Derow, H.; Farwell, B. E. (Aerojet-General Corp., Azusa, Calif.). July 1966. Contract NAS5-417. 128p.

Investigations were conducted in support of the design, fabrication, and development testing of various SNAP-8 components and system loops. Operation of a Hg forced-convection corrosion loop was conducted with the aim of evaluating the corrosion resistance of 9Cr–1Mo alloy steel (the reference Hg containment material) for 10,000 hour service. Data were developed in a continued program to evaluate the effects of the SNAP-8 turbine operating environment on Satellite 6B (the reference aerodynamic material). (auth)

20474 (NASA-CR–72177) ADVANCED REFRACTORY ALLOY CORROSION LOOP PROGRAM. Quarterly Progress Report No. 6, July 15, 1966–October 15, 1966. Harrison, R. W. (ed.) (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). Oct. 24, 1966. Contract NAS 3-6474. 31p.

Developments in monitoring the fabrication of the advanced refractory alloys are described. Production of most of the T-111 alloy tubing was completed, and all the Mo–TZC and Cb-132M materials have been received. Assembly of the Li still is in progress. A study has been initiated to evaluate the corrosion resistance of advanced Ta alloys, ASTAR 811 (Ta–8W–1Hf–1Re) and ASTAR 811 CN (Ta–8W–1Hf–0.012C–0.12N), to K and Li. (auth)

20475 SURFACE ANALYSIS. Brush, E. G.; Leistikow, S.; Pearl, W. L. (General Electric Co., San Jose, Calif.). Nucl. Appl., 3: 6-7(Jan. 1967).

A study of the compositionally changed region in the alloy phase near the oxide/alloy interface resulting from the partial selective oxidation of Incoloy-800 was made. A method was developed to obtain an average surface analysis on a spot of about 3 cm^2 on the compositionally disturbed metallic layer next to the oxide scale. A controlled anodic dissolution of a few microns at a time followed by an x-ray fluorescence analysis permits the definition of the disturbed layer as well as an integrated measure of the composition of the metal reacted. (D.H.M.)

20476 KINETICS OF TANTALUM CORROSION IN AQUEOUS ELECTROLYTES. I. Lehovec, K.; D'Amico, J. (Sprague Electric Co., North Adams, Mass.). J. Electrochem. Soc., 114: 363-7(Apr. 1967).

The spontaneous growth of thin (6–20Å) oxide films on Ta immersed into aqueous solutions of H_2SO_4, NaCl, and NaOH was investigated by means of capacitance and voltage measurements. There was a rather rapid initial oxide-growth rate in NaOH until a thickness of about 12Å was reached. Beyond that thickness and over the entire thickness range in the other electrolytes, the oxide thickness increased roughly in proportion to the logarithm of time. There was a small, but well established dependence of "oxide capacitance" on the pH of the electrolyte in which it was measured and a rather large, reversible temperature dependence of the ox-

ide capacitance, which indicate that these thin oxide films do not behave as an ordinary dielectric. (auth)

20477 KINETICS OF THE ATTACK OF HIGH-TEMPERATURE MOLYBDENUM AND TUNGSTEN BY ATOMIC OXYGEN. Rosner, Daniel E.; Allendorf, H. Donald (AeroChem Research Labs., Inc., Princeton, N. J.). J. Electrochem. Soc., 114: 305-14(Apr. 1967).

Using microwave discharge, fast-flow system techniques coupled with resistance heating and monitoring of the reacting specimens, the true kinetics of metal atom removal for polycrystalline Mo and W filaments attacked by atomic O were obtained in the nominal temperature range from 1000 to 2200°K at oxygen-atom pressures in the range from 10^{-3} to 5×10^{-2} torr. Under these conditions the oxides of Mo and W essentially volatilize as rapidly as they are formed, leaving the metal surface vulnerable to direct O attack at constant (time independent) rates. Reaction probabilities were found up to 140 times those for O_2 attacking the same surface, were independent of O-atom partial pressure, and exhibited a much weaker temperature dependence than those for O_2. These observations are in accord with a Rideal-type mechanism in which O atoms from the gas phase strike chemisorbed O, leading either to product formation and desorption, or surface-catalyzed O-atom recombination. (auth)

Preparation and Fabrication

Refer also to abstracts 20472 and 20547.

20478 (AERE-Bib-153) VIBRATORY COMPACTION OF METAL AND CERAMIC POWDERS. Jones, P. J. (comp.) (Atomic Energy Research Establishment, Harwell (England)). Feb. 1967. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 1s. 9d.

Sixty-seven references are given to reports, books, and journals published from 1953 through 1966. Sources are listed and an author index is provided. (UKAEA)

20479 (CEA-R-2992) CONTRIBUTION A L'ETUDE DES MECANISMES DE FRITTAGE DE POUDRE D'URANIUM EN PHASES α, β, ET γ. (Contribution to the Study of the Sintering Mechanisms of Uranium Powders in the α, β, and γ Phases). Pinteau, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 64p. (In French). Dep. mn.

Thesis. Submitted to Univ., Paris.

Sintering mechanisms for U powders prepared by calciothermy were studied by continuous dilatometric measurements of the shrinkage of samples previously compressed at room temperature in purified Ar gas. The tests carried out in the α, β, and γ phases led to the observation that the first step in sintering appears to be governed by a volume self-diffusion mechanism; the activation heat values found for the sintering mechanisms were close to those deduced during studies of volume self-diffusion using the direct radiotracer method. Furthermore it has been possible to show that in the γ domain a second sintering mechanism occurs involving much longer sintering times; the heats of activation are much lower and this appears to indicate that a mechanism involving pore elimination by grain-boundary diffusion of the vacancies occurs. (auth)

20480 (AD-645855, pp 1-19) THE IMPORTANCE OF METALLIC MOLYBDENUM AND OF VARIOUS MOLYBDENUM-BASED PRODUCTS IN MODERN TECHNOLOGY. Domsa, A. Translated from Bul. Stiint. Inst. Politeh. Cluj, No. 7, 169-80(1964).

A review is presented on the fabrication, properties, and uses of Mo and its compounds and alloys. Powder metallurgy methods are used for fabricating Mo. The preparation and uses of $MoSi_2$ and lubricating properties of MoS_2 are also discussed. It is emphasized that high purity is very important when working with Mo. Impurities of O, N, and C, even in small amounts, exert a damaging effect. Data are given on the hardness of Mo as a function of alloying additions, such as Ti, Zr, Ta, Nb, Cr, W, and Be. (P.C.H.)

20481 (AD-645855, pp 29-34) DIFFUSION OF MOLYBDENUM FROM THE POWDER STATE ON METALLIC SURFACES. Filipescu, Mihaela. Translated from Bul. Stiint. Inst. Politeh. Cluj, No. 7, 231-6(1964).

Coating of metals by solid-state diffusion of Mo from powders was investigated. Carbon steels were used as the base materials. The temperature of 1100°C was found to be the most effective one on the basis of the thickness of the diffusion layer. Results showed that by increasing the length of the soaking period, the thickness of the diffused layer increases. (P.C.H.)

20482 ELECTROPOLISHING NIOBIUM. Pelleg, J. (National Research Council, Ottawa). J. Less-Common Metals, 12: 421-2(May 1967).

The disadvantages of a $HF-H_2SO_4$ electrolyte for use in electropolishing Nb were overcome by the addition of lactic acid. The successful electrolyte contained 18% HF, 34% H_2SO_4, and 48% lactic acid. The best polish occurred at 4.2V and 200 mA/cm^2. (M.C.G.)

20483 COMPARISON OF THE BEHAVIOR OF DIFFERENT METALS UNDER THE IMPACT OF THE ELECTRON BEAM IN A WELDING MACHINE. Boncoeur, M. (Commissariat a l'Energie Atomique, Montrouge, France). Mem. Sci. Rev. Met., 64: 45-51 (Jan. 1967). (In French).

The properties of U, especially its ionization in an electron beam, greatly affect the conditions for welding it by electron bombardment. It is shown to be difficult to eliminate formation of a crater at the final point of a weld in uranium. (auth)

20484 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 9: 255-65(Winter 1966-1967).

Recent research in special fabrication techniques related to reactor materials is reviewed. 53 references are cited. (B.L.M.)

20485 PRODUCTION OF URANIUM METAL FROM URANIUM OXIDE BY FUSED SALT ELECTROLYSIS. Piper, Roger D. (Mallinckrodt Chemical Works, Weldon Spring, Mo.). Electrochem. Technol., 5: 147-51(Mar.-Apr. 1967).

Two approaches were developed for electrolytic production of molten U metal at 1170°C directly from UO_2. In one approach, use of a $BaF_2-LiF-UF_4$ electrolyte gave up to 44% current efficiency over a wide range of current densities. The other approach gave up to 80% current efficiency by using a $CaF_2-LiF-UF_4$ electrolyte in a cell operated with temperature gradient to form a crust of solid CaF_2 on the walls. Both approaches yielded good-quality metal suitable for nuclear reactor fuel. (auth)

20486 VAPOR-PLATING ALUMINUM ON BERYLLIUM FOR WELDING. Westlund, E. F.; Lohmann, H. G. (Univ. of California, Livermore). Weld. J. (N. Y.), 46: 207-10(Mar. 1967). (UCRL-14971).

A technique was developed for vapor plating Al on Be and welding the surfaces with an electron-beam welding unit. Three methods of adding Al to the joint were investigated: placing a sheet of Al in the joint before welding was unsuccessful because the weld metal bubbled and made the beam erratic; both precoating the surface with Al wire using a gas W-arc under pressure and precoating by vacuum evaporation of Al were successful. The full-penetration weld was stronger than the hot-pressed S-200 Be. The quantity of Al in the joint was much less in the braze welding used with a gas W-arc under pressure. (P.C.S.)

Properties Evaluations

Refer also to abstracts 19796 19897, 20480, and 21088.

20487 (BNWL-378) A STUDY OF TUNGSTEN-TECHNETIUM ALLOYS. Quarterly Progress Report, January 1, 1966-April 1, 1966. Kemper, R. S.; O'Keefe, D. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1967. Contract AT-(45-1)-1830. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A bend test fixture was built in order to determine the effects of Tc content on the ductile-brittle transition temperature of W using small amounts of material. Ductile-brittle transition data for pure W specimens are given. Future work with this equipment involves establishing a procedure for defining the permanent set before fracture in terms of bend angle and thickness. (P.C.H.)

20488 (COO-841-6) ON THE ELECTRICAL RESISTIVITY OF LIQUID METALS: CONSTANT PRESSURE. Lien, S. Y.; Sivertsen, J. M. (Minnesota Univ., Minneapolis. Dept. of Mineral and Metallurgical Engineering). [1963]. Contract AT-(11-1)-841. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A theory is given for the structure-dependent scattering as a function of temperature which is responsible for the resistivity of a simple liquid metal such as Na or one of the other alkalis. If one assumes that the total disorder of the liquid contributes to the resistivity, one may introduce the radial distribution function of the liquid into the analysis. This description of the disorder is equivalent to a distribution of correlated density fluctuations given in terms of the radial distribution function. The temperature dependence of the resistivity then arises from the temperature dependence of the radial distribution curve which in turn is due to the correlated thermally activated density fluctuations in the liquid. Results are obtained for both the constant pressure and constant volume cases. Measurements of the temperature dependence of the resistivity at constant pressure of Na and Hg are reported and described. The behavior of Na and Hg are quite similar and agree qualitatively with the theory. Comparison is made between the calculations and Ziman's theory. It is concluded that the temperature dependence of the short-range order in the liquid rather than

plasma scattering is responsible for the temperature dependence of the electrical resistivity. (auth)

20489 (NAA-SR-Memo-11328) CREEP: A COMPUTER CODE TO INVESTIGATE CREEP BOWING OF PROCESS TUBES. Morgan, J. G. (Atomics International, Canoga Park, Calif.). Apr. 23, 1965. Contract AT-11-1-GEN-8. 40p. Dep. mn. $3.00 cy, $0.65 mn.

CREEP is a code that calculates the deflection, bending moment, and stresses of process tubes, which are subject to creep bowing, designed for use in the 1000 MW SGR and 200 MW Prototype reactors. Printed output and CRT output of the results are given for each case run on the code. (auth)

20490 (NYO-3560-7) TRANSFORMATIONS IN AB_2 INTERMETALLIC COMPOUNDS. Progress Report, March 1, 1966–February 28, 1967. Ryba, Earle (Pennsylvania State Univ., University Park. Dept. of Metallurgy). Mar. 1, 1967. Contract AT(30-1)-3560. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments in studies on phase transformations, crystallography, electronic properties, and mechanical properties of type-AB_2 intermetallic compounds are reported. A large number of runs on several $HoZn_2$ samples revealed that the x-ray diffraction pattern changed when the sample was heated. However, no phase transition occurred in this compound over the range room temperature to 900°C. Thermal expansion data for $HoZn_2$ are given. Lattice parameters for $NdZn_2$, $GdZn_2$, and $TbZn_2$ are tabulated. Data on the magnetic susceptibilities and microhardness of a number of $REZn_2$ (RE = rare earth) compounds are also given. (P.C.H.)

20491 (UCRL-16350) VAPOR PRESSURE STUDIES OF IRON-MANGANESE ALLOYS. Roy, Prodyot; Hultgren, Ralph (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1965. Contract W-7405-eng-48. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Mn vapor pressures from 1250 to 1500°K were measured by conventional Knudsen and torsion-effusion methods in twelve Fe–Mn alloys with compositions from 9–80 at. % Mn. The Knudsen results agreed approximately with previous measurements found in the literature which indicated the solutions were nearly ideal. However, except for the higher Mn compositions, the initial torsion readings indicated much (up to 50%) higher vapor pressures than the Knudsen method. These high readings decreased steadily with time. The results are interpreted as due to depletion of surface concentration of Mn during evaporation. Thus the initial torsion readings are the most nearly correct and Knudsen methods on alloys are to be regarded with suspicion unless it can be demonstrated that diffusion rates are rapid enough to replenish surface concentrations depleted by evaporation. For the lowest Mn contents and highest temperatures, depletion causes initial torsion readings to be too low. (auth)

20492 (AD-645855) SCIENTIFIC BULLETIN OF THE CLUG POLYTECHNIC INSTITUTE (SELECTED ARTICLES). Translated from Bul. Stiint. Inst. Politeh. Cluj, No. 7, 169-80; 213-21; 231-6(1964). 36p. (FTD-TT-65-835). CFSTI $3.00 cy, $0.65 mn.

Three articles are included; separate abstracts were prepared for two. The remaining article on pressing and sintering properties of I.C.P. type molybdenum powders was previously abstracted in NSA as 20: 43867. (P.C.H.)

For abstracts of individual papers see: 20480 and 20481.

20493 TEMPERATURE DEPENDENCE OF ELASTIC MODULI OF RUTHENIUM, RHENIUM, COBALT, DYSPROSIUM, AND ERBIUM; A STUDY OF THE ELASTIC ANISOTROPY-PHASE TRANSFORMATION RELATIONSHIP. Fisher, E. S.; Dever, D. (Argonne National Lab., Ill.). Trans. Met. Soc. AIME, 239: 48-57 (Jan. 1967).

Measurements of the temperature dependence of the elastic moduli in single crystals of hcp Ru, Re, Co, Dy, and Er were carried out for between 4 and 1123°K to investigate the correlation between the shear anisotropy ratio, $A = c_{44}/c_{66}$, and the occurrence of the hcp → bcc phase transformation. Measurements confirmed the suggestion that A has a positive temperature dependence in that group of hcp metals that undergo thermally induced transformations to the bcc structure and a negative or zero temperature dependence in the other hcp metals. It appears, from indirect evidence, that the hcp → fcc transformation in Co is preceded by a highly negative temperature dependence of A. These results indicate that elastic anisotropy is an important factor in determining the temperatures at which martensitic phase transformations occur. Two possible roles for elastic anisotropy are proposed: the shear-modulus ratio within the habit planes must be nearly similar for the two phases, and a large anisotropy decreases the stress necessary for the movement of the transformation dislocations. (auth)

20494 MICROPLASTICITY IN A Cu-1.9 Wt PERCENT Be PRECIPITATION-HARDENING ALLOY. Bonfield, W. (Honeywell Research Center, Hopkins, Minn.). Trans. Met. Soc. AIME, 239: 99-106(Jan. 1967).

The microstrain characteristics of a polycrystalline Cu 1.9 wt % Be precipitation-hardening alloy were determined for various conditions of aging. The friction stress remained constant for all conditions, whereas the microscopic yield stress (the stress to produce a plastic strain of 2×10^{-6} in. per in.) and the three-stage stress-strain curve in the microstrain region were sensitive to changes in dislocation and precipitate distribution. Correlations between the measurements of microplasticity and electron-microscope observations of substructure are considered. (auth)

20495 SELECTION OF MATERIALS FOR BOILERS AND NUCLEAR REACTORS. Lorentz, Roy E. Jr.; Harding, Walter L. (Combustion Engineering, Inc., Chattanooga). Metal Progr., 91: No. 4, 95-100(Apr. 1967).

A review on proper selection of materials for boilers and nuclear reactors is presented. Strong, ductile materials are needed for the plates, sheets, forgings, castings, piping, tubing, and extruded shapes for pressure vessel fabrication. The effect of high temperature on stress in boiler materials is of prime importance. In the selection of materials for high temperature service, the corrosion resistance and creep rupture strength of the material must be balanced against the higher cost of alloys which have the needed properties. Design and fabrication techniques which eliminate low temperature brittleness caused by notches are recommended. (J.G.B.)

20496 INFLUENCE OF A SMALL URANIUM ADDITION ON THE MECHANICAL AND MAGNETIC PROPERTIES OF 50-50 IRON-NICKEL ALLOY. Josso, E. Rev. Met. (Paris), 63: 915-19(Nov. 1966). (In French).

The desulfurizing effect of a U addition, not exceeding 0.10%, increased considerably the hot deformability of the alloy. This addition was less harmful than Mn to the magnetic properties. This was due to the formation of a globular sulfide that is chemically stable and greatly heat-resistant. (auth)

20497 REFRACTORY METALS BRAZED FOR OPERATION AT 2200 F. Baciarelli, Renato M. (Aerojet-General Nucleonics, San Ramon, Calif.). Metal Progr., 91: No. 4, 189-92(Apr. 1967).

Tests were made at 2200° F and above on braze alloys to be used in thermionic devices which would convert heat from a liquid metal carrying tube directly to electrical energy. An Al_2O_3 coating was used as the insulator for Mo and Nb parts of the thermionic converters which were joined by filler metals. Tests on joints of 65Co–36Pd, 50Au–25Pd–25Ni, 87Au–13Pd were not successful. Direct metal-to-metal test brazes in Mo indicated that three other filler metals — pure Ti, pure Ni, and 60Ni–35Mo–5Fe — made sound joints that could withstand exposure to 2200° F for 205 hr. Joints between concentric tubes of Mo and Nb in which the inner tube was coated with 0.008 in. of TiO_2-stabilized Al_2O_3 and 0.004 in. of Mo, supported this finding. (J.G.B.)

20498 CAVITATION DAMAGE STUDIES WITH ROTATING DISK IN WATER. Wood, G. M. (Pratt and Whitney Aircraft Div., United Aircraft Corp., East Hartford, Conn.); Knudsen, L. K.; Hammitt, F. G. J. Basic Eng., 89: 98-110(Mar. 1967).

The cavitation-damage resistance of alloys of Al, Nb, Ta, Mo, and stainless steel was evaluated in water using a rotating-disk apparatus. The alloys in decreasing order of cavitation resistance were Ta–8W–2Hf, Nb–18W–8Hf, Ta–10W, 316SS, Mo–.5Ti, Nb–1Zr, Al–4Cu–.7Mn–.5Mg, and Al–2.5Mg–.25Cr. The damage resistance order did follow the variation of any single property such as strain energy to failure, yield strength, or hardness, but appeared to be a combination of mechanical properties and phase structure. Photomicrographs show predominant intergranular cracking for the Mo alloy and transgranular erosion and cracking for the remaining alloys tested. The second phase precipitate in the Al alloy appears to hinder the erosion of material. Investigation of small variations in the grain size of the heat-treated Nb–1Zr alloys showed some variation in damage resistance, with the largest grain structure exhibiting the highest resistance. Correlation curves of volume loss as a function of the peripheral velocity are presented for all materials tested. In addition, the operation of the rotating-disk apparatus was examined in considerable detail and the effects of various design changes were evaluated. (auth)

20499 ELASTIC CONSTANTS OF MAGNESIUM THORIUM ALLOY. Asay, J. R. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). J. Basic Eng., 89: 93-7(Mar. 1967).

The longitudinal and shear-wave velocities in a polycrystalline sample of Mg–Mn–Th alloy were measured by a pulse transmission technique as a function of temperature. Temperatures

ranged from 25 to 350°C for longitudinal wave measurements and about 220°C for shear measurements. The resulting velocity data were used to calculate elastic properties of the material, including Young's modulus, shear modulus, bulk modulus, and Poisson's ratio. The resulting least squares fits for these data are: Longitudinal velocity, $c_l = 5.749 - 3.987 \times 10^{-4}\ T - 1.139 \times 10^{-6}\ T^2$ mm/μsec; shear velocity, $c_t = 3.108 - 1.421 \times 10^{-4}\ T - 2.588 \times 10^{-6}\ T^2$ mm/μsec; bulk modulus, $B = 3.576 \times 10^{11} - 2.744 \times 10^{7}\ T + 1.187 \times 10^{5}\ T^2$ dynes/cm²; Young's modulus, $E = 4.435 \times 10^{11} - 1.415 \times 10^{7}\ T = 6.037 \times 10^{5}\ T^2$ dynes/cm²; shear modulus, $G = 1.716 \times 10^{11} - 7.994 \times 10^{6}\ T - 2.619 \times 10^{5}\ T^2$ dynes/cm²; Poisson's ratio, $\sigma = 0.293 - 6.459 \times 10^{-6}\ T + 3.392 \times 10^{-7}\ T^2$. (auth)

20500 BEHAVIOR OF Th–20 WT PERCENT U FAST-REACTOR FUEL UNDER TRANSIENT HEATING TO FAILURE. Dickerman, C. E.; Robinson, L. E.; Blumenthal, B.; Stewart, R. (Argonne National Lab., Ill.). Nucl. Appl., 3: 9-17(Jan. 1967).

Na-bonded Th–20 wt % U fast-reactor-type fuel elements were studied in transient meltdown experiments ranging up to complete sample meltdown, conducted in the TREAT reactor. The high-melting Th matrix supported the fuel during transient heating at temperatures significantly beyond the solidus. Because the fuel was still relatively intact at the temperatures of cladding failure, internal pressure was not effective in ejecting fuel upon failure. The dominant mechanism of fuel movement was gravity. (auth)

20501 NEW ULTRASONIC METHOD OF STUDYING THE MIGRATION OF POINT DEFECTS TO DISLOCATIONS. Mazzolai, Fabio Massimo; Nuovo, Mario (Istituto Nazionale di Ultracustica, Rome). Ric. Sci., 36: 1307-15(Dec. 1966). (In Italian).

The migration of point defects to dislocations produced pinning points and changed characteristic parameters of the low-temperature dislocation relaxation effect (Bordoni peak). Measurement of the Bordoni peak variations during an annealing treatment can be used to investigate diffusion processes. This method was applied to study the migration of oxygen interstitials in Ta. (auth)

20502 EMBRITTLEMENT OF Nb BY HYDROGEN AT AMBIENT TEMPERATURE; INFLUENCE OF COLD-HAMMERING. Kieger, Roger; Clauss, Auguste (Univ., Strasbourg). Compt. Rend., Ser. C, 264: 664-7(Feb. 20, 1967). (In French).

The influence of preliminary cold-hammering on the embrittlement of niobium by hydrogen was studied. A correlation between the elastic limit of niobium and its capacity for deformation by hydrogen was observed. (tr-auth)

20503 STRUCTURE SENSITIVITY OF PLASTIC PROPERTIES OF ELECTRON-BEAM-MELTED MOLYBDENUM ALLOYS. Efimov, A. I.; Kushnareva, N. P.; Statkevich, V. N.; Trefilov, V. I. (Inst. of Metal Physics, Kiev. Inst. of Electric Welding, Kiev). Fiz. Metal. Metalloved., 22: 227-33(Aug. 1966). (In Russian).

Specimens of electron-beam melted Mo and Mo–C–Ti and Mo–B–Ti alloys have been subjected to bending tests in the as-cast and annealed (in vacuum at 2000°C for 1 hr) conditions. It was found that the plasticity of Mo alloys depends, to a great degree, on their structure. Specimens of pure Mo and Mo–C–Ti alloy cut from the ingots along their longitudinal axes had crystals positioned in the lengthwise direction and they were plastic. As-cast pure Mo longitudinal specimens withstood bending to 180°, without failure, while annealed specimens failed at 150° in a transcrystalline manner. Specimens of Mo–C–Ti alloy broke at a 150 to 160° bending angle with a fracture along the grain. Specimens of pure Mo and Mo–C–Ti alloy cut across the ingot axis were predominantly brittle and broke at 0°, with the exception of annealed specimens which broke at 70 to 90°. All longitudinal and crossectional specimens of Mo–B–Ti alloy were brittle, showing predominantly transcrystalline fracture. It was established that alloys with high plasticity have clearly developed fragmentation and a disorientation of substructure fragments of 2 to 4°. (ATD)

20504 CARBON DIFFUSION INTO REFRACTORY METALS WITH A BCC LATTICE. Nakonechnikov, A. I.; Pavlinov, L. V.; Bykov, V. N. Fiz. Metal. Metalloved., 22: 234-8(Aug. 1966). (In Russian).

Specimens of 99.98%-pure Mo, 99.14%-pure Nb_0, 99.51%-pure W, 99.01%-pure Ta, annealed at 1500°C, and 99.62%-pure Ti, annealed at 1000°C, were coated with a uniform thin layer of ^{14}C and, after stacking into pairs with the active sides facing each other, were diffusion annealed in a vacuum of (3 to 5) × 10^{-5} mm Hg at 1100 to 1600°C. The diffusion coefficient and activation energy were determined with an accuracy of about 12 and 5%, respectively. With increasing annealing temperature from 1200 to 1600°C, the diffusion coefficient increased from 1.34×10^{-8} to 4.24×10^{-7} cm²/sec for Mo, from 8.61×10^{-10} to 5.15×10^{-8} cm²/sec for W, and from 1.05×10^{-6} to 2.51×10^{-7} cm²/sec for Ta. For Nb and Ti, diffusion annealed in the 1100 to 1400°C range, the diffusion coefficient varied from 2.49×10^{-8} to 4.88×10^{-7} cm²/sec and from 1.75×10^{-6} to 7.27×10^{-6} cm²/sec, respectively. In the same temperature ranges, the calculated values of the activation energy were 53500, 43000, 41000, 35000, and 20000 cal/g · atom for W, Ta, Mo, Nb, and Ti, respectively. Thus, the activation energy for Ca diffusion into metals with a bcc lattice is directly proportional to the melting temperature of the base metal, and can be expressed by the equation $\Delta H = kT_{mel}$, where $K \approx 10$ to 13. The frequency factor for the carbon diffusion into the bcc metals is, to a great extent, determined by the activation energy, and can be expressed by the equation $D_0 = A \exp(b\Delta H)$, where $A = 3.2 \times 10^{-4}$ cm²/sec and $b = 10^{-4}$ cal/g · atom. (ATD)

20505 STRUCTURAL CHANGES IN ROLLED TUNGSTEN AT PRECRYSTALLIZATION HEATING. Spektor, E. N.; Gorelik, S. S. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvetn. Met., No. 1, 103-4(1967). (In Russian).

Structural changes in W rolled from 1mm to 0.2mm at 1100°C and below were studied. W transition from 0.35mm to 0.2mm took place at 700°C. Analysis of ductility as a function of annealing temperature showed two areas of ductility; one at 400 to 500° with ductility increase of 10 to 20% and at 900° with 5 to 10% increase. Two areas of electric conductivity drops coinciding with the regions of $\sigma_{0.005}$ ductility increase were also found. Hardness changes were negligible. (R.V.J.)

20506 INVESTIGATION OF THE STRUCTURE AND PROPERTIES OF MOLYBDENUM–NIOBIUM ALLOY SINGLE CRYSTAL. Savitskii, E. M.; Burkhanov, G. S.; Bokareva, N. N.; Khazov, N. P. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR, 171: 577-9(Nov. 21, 1966). (In Russian).

Single crystals of Mo–Nb alloys containing 0 to 100% Nb were grown from alloy bars obtained by vacuum melting components which contained 0.001 to 0.002% O_2, 0.0001 to 0.0005% H_2, and 0.01% C. All the crystals grown had [100] or [110] orientation. It was found that the electrophysical and mechanical properties of alloy single crystals strongly depended on the orientation. The highest ductility was found in crystals with [110] orientation. Differences in strength, reduction of area, and elongation between the crystals with [100] and [110] orientations were up to 50%. No anisotropy of hardness was observed. The content of interstitial impurities significantly affected the elongation and reduction of area. Increasing the second component in Mo–Nb alloys increased the strength of single crystals and decreased the ductility following the same pattern as that of polycrystalline alloys. Single crystals of Mo, Nb, and their alloys with up to 20% of the second component have a high ductility with a reduction of area of over 50%. Alloys containing over 40% of the second component have a lower ductility and fail along the cleavage plane [100]. (ATD)

20507 METHODS FOR IMPROVING THE DUCTILITY OF MOLYBDENUM. Loria, E. A. (National Steel Corp., Weirton, W. Va.). J. Less-Common Metals, 12: 425-8(May 1967).

The methods of Semchyshen and Barr were extended to a less pure but unique crystalline form of Mo (electron on) and it was found that small Al and Mg additions did not affect mechanical properties, but γ strengthened and hardened the sheet product and raised the recrystallization temperature. A solid-solution softening effect was not noted for Al or Mg because of the higher amount of C and O_2 in the charge material. Nevertheless, the acicular shape and the consolidation procedures employed contributed grain size and carbide dispersion effects that actually improved workability and ductility. The ductile-brittle transition temperature of recrystallized Mo was shown to be significantly affected by the number of grains through the specimen cross section and the nature of the carbide dispersion. (M.C.G.)

20508 MAGNETIC PROPERTIES OF Dy–Y ALLOYS. Shafigullina, G. A.; Chechernikov, V. I.; Markova, I. A. (Moscow State Univ.). Fiz. Metal. Metalloved., 22: 839-42(Dec. 1966). (In Russian).

An experimental investigation was conducted on the magnetic properties of Dy–Y alloys throughout the range of concentrations in the temperature interval of from 100 to 1000°K in the presence of magnetic fields of various intensity. Nine alloys of this system, containing 5.7 to 83 at. % Dy were obtained by multiple remelting and vacuum annealing. Magnetic susceptibility was measured by the conventional ponderomotive method using a magnetic balance. Findings: magnetic susceptibility χ and crystal lattice constants a and c change monotonically over the entire concentration range. The temperature dependence of reverse susceptibility $1/\chi$ is linear, thus making it possible to calculate the effective atomic magnetic moment p_p of the alloys as well as to determine the paramagnetic Curie point θ_p. Within the investigated temperature range, the magnetic susceptibility of Dy–Y alloys follows the

Curie–Weiss law. p_p and θ_p of the alloys vary monotonically as a function of the alloy composition, and the magnetic moment calculated per atom of Dy corresponds to the trivalent ion of this element in fundamental state. In the low temperature range there occurs a transition from antiferromagnetic to paramagnetic state, which shifts in the direction of low temperatures with increase in the magnetic field intensity. All this indicates that the magnetic properties of Dy–Y alloys are chiefly conditioned by localized 4f-electrons, while in the antiferromagnetism region there apparently exists a spiral-like magnetic structure resembling the structure observed for pure Dy. (D.L.C.)

20509 OPTICAL PROPERTIES OF DILUTE TUNGSTEN–RHENIUM SOLID SOLUTIONS. Leksina, I. E.; Penkina, N. V. (Baikov Inst. of Metallurgy, Moscow). Fiz. Metal. Metalloved., 22: 264-7(Aug. 1966). (In Russian).

A study was made of the optical constants (index of refraction and absorption coefficient) in dilute solid solutions of W and Re with Re concentration approaching 1.6 at. % in the 0.5 to 8.0 μ spectral region. 99.97% pure VChDK W powder and 99.98% pure (GOST 88–59) Re powder were used for making the specimens. The samples were hydraulically pressed, degassed, and sintered at 1200°C in a 5×10^{-6} mm Hg vacuum. As a final step, the specimens were melted in an arc furnace in an Ar atmosphere. In order to ensure homogeneity and relieve stress, the specimens were annealed in a vacuum at 1500°C for 15 hours. Some of the specimens were subjected to local x-ray analysis to determine Re content. This analysis showed that Re was uniformly distributed throughout the specimens. An additional analysis was carried out to determine gas content in the specimens. The results of this analysis showed that the specimens contained 0.003% O_2 and 0.02% N_2. The Drude method was used for measuring the optical constants in the 0.49 to 1.0 μ spectral region and the Beattie and Conn method was used for measuring these constants in the 1.5 to 8.0 μ region. Four sets of measurements were taken and the values for the refractive indices and absorption coefficients were averaged. The average errors in determining the index of refraction and absorption coefficient in the 0.5 to 1.0 μ spectral region were 8 and 5% respectively, and 15 and 6% in the 1.5 to 8.0 μ region. The results of the experiments show that W has a wide absorption band encompassing the visible and infrared regions of the spectrum up to 4 μ. This band, though somewhat deformed, was present throughout the entire series of experiments on W–Re alloys. A diagram is given showing the long wave absorption edge for all specimens. These data show that increasing Re concentration shifts the edge of the band into the long wave region. Variation in the location of the edge of the band is approximately 0.1 eV with the addition of 1 at. % of Re. For the case of 6 to 7 μ waves, where optical properties are determined by electron conductivity and the contribution from quantum absorption is small, conduction electron concentration was calculated by using the normal skin effect formula. It was found that the concentration of conduction electrons in W–Re solid solutions is a constant 1.3 to $1.4 \cdot 10^{22}$ el/cm^2 for Re concentrations up to 1.6 at. %. (ATD)

20510 REFRACTORY CERAMIC-TO-METAL SEAL. Milch, Alfred; Lalak, Joseph J.; Ahlert, R. H. (Philips Labs., Briarcliff Manor, N. Y.). Electrochem. Technol., 5: 83-6(Mar.–Apr. 1967).

A novel ceramic-to-metal seal was developed that remains vacuum tight after recycling to 1800°C and during exposure at 1500°C to Cs vapor. Destructive tensile testing at 1000°C of ceramic bodies joined by this seal generally resulted in rupture of the ceramic while leaving the seal itself vacuum tight. The seal was successfully formed between various combinations of refractory oxide ceramics such as high-purity Al_2O_3 (including G. E. Lucalox and synthetic sapphire), MgO, and spinel, and refractory metals such as Mo, W, and Re. Best results thus far were obtained with Al_2O_3 joined to Mo. A less refractory version of this seal can be formed at considerably lower temperatures with the use of conventional brazing materials. (auth)

20511 MAGNETIC PROPERTIES OF SOME ALLOYS OF THORIUM WITH HOLMIUM AND ERBIUM. Koehler, W. C.; Child, H. R.; Cable, J. W.; Moon, R. M. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 38: 1384-5(Mar. 1, 1967).

Neutron-diffraction studies have been carried out on a number of alloys of Th with the heavy rare earth metals Ho and Er, as part of an investigation of the nature of the exchange interaction in these materials. At room temperature, the heavy rare earths in question crystallize in the simple hcp structure; Th, in the ccp structure. Alloys containing more than about 80 at.% rare earth are found in the hcp structure, and those with less than about 50 at.% are found in the ccp arrangement. The three outer electrons of the rare earth metals ($5d^16s^2$) are presumed to form conduction bands, and it is generally accepted that magnetic coupling in the rare earth metals occurs via an indirect interaction involving a polarization of the conduction electrons. Th, a tetravalent diluent (outer electron configuration $6d^27s^2$), provides a means of changing the effective number of conduction electrons on alloying of the rare earths. In contrast to the effect of trivalent Y and Lu as diluents, small additions of Th tend to stabilize the ferromagnetic state in the hcp structure. Attempts at correlation of the results with the Ruderman–Kittel–Kasuya–Yosida theory have been made but with indifferent success. (auth)

20512 PARAMAGNETIC FORM FACTOR OF GADOLINIUM. Child, H. R.; Moon, R. M.; Raubenheimer, L. J.; Koehler, W. C. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 38: 1381-3 (Mar. 1, 1967).

A sample of Gd_2O_3 enriched to about 98% in the low-absorbing isotope ^{160}Gd was examined by neutron diffraction at temperatures from room temperature to 1.3°K. Measurements of the diffuse background scattering in the high- and intermediate-temperature patterns have been used to obtain the paramagnetic form factor as a function of $\sin\theta/\lambda$. The observed scattering cross section was converted to f^2 values by assuming the full theoretical paramagnetic moment of $g[J(J+1)]^{\frac{1}{2}}$ for Gd^{+3} and using this value to correct for the isotropic nonmagnetic part of the scattering. The form factor obtained in this manner is near the calculated Hartree–Fock free-atom form factor but appears to be slightly higher over most of the region out to $\sin\theta/\lambda \cong 0.3$ Å^{-1}. Beyond this value, overlapping nuclear reflections in the powder pattern make it impossible to obtain usable values of the background intensity. Magnetic ordering of a complex antiferromagnetic nature appears at about 1.6°K but a large diffuse hump in the pattern remains to a few degrees above liquid He temperature. This hump never completely disappears at the lowest temperatures reached indicating the magnetic structure is by no means fully developed at 1.3°K. (auth)

20513 MAGNETIC ANISOTROPY OF TERBIUM AND DYSPROSIUM. Rhyne, J. J.; Clark, A. E. (Naval Ordnance Lab., Silver Spring, Md.). J. Appl. Phys., 38: 1379-80(Mar. 1, 1967).

The enormous magnetic anisotropy of Tb and Dy has been studied in the temperature range from 11°K to near the Néel points. In order to directly determine the large axial anisotropy ($> 10^8$ erg/cm^3), a unique torque pendulum was used in which the difference between the specimen torque and that of a fixed-coil dipole was determined as a function of applied field. Torque data on single crystals of Tb and Dy in fields up to 140 kOe yielded values of the uniaxial anisotropy constant K_2 of 5.5×10^8 erg/cm^3 at 11°K to 1.7×10^8 erg/cm^3 at 205°K for Tb, and 5×10^8 erg/cm^3 at 22°K to 1.7×10^8 erg/cm^3 at 152°K for Dy. The temperature dependence of the data agrees with that calculated from the single-ion interaction theory: $K_2(T) = K_2(0)\,\hat{I}_{\frac{5}{2}}[\mathcal{L}^{-1}(m)]$ where $\hat{I}$ is a normalized hyperbolic Bessel function and $\mathcal{L}^{-1}$ is the inverse Langevin function of the reduced moment. The sixfold basal-plane anisotropy of Dy and Tb was obtained from an analysis of the angular dependence of the basal plane magnetostriction. Values of the basal-plane anisotropy constant K_6^6 for Tb ranged from 2.4×10^6 erg/cm^3 at 4°K to 2×10^5 erg/cm^3 at 140°K, and for Dy from 7.5×10^6 erg/cm^3 at 4°K to 2×10^5 erg/cm^3 at 120°K. As in the case of K_2, the strong monotonic temperature dependence can be adequately represented by the single-ion expression. Here $K_6^6(T) = K_6^6(0)\,\hat{I}_{\frac{11}{2}}[\mathcal{L}^{-1}(m)]$. (auth)

20514 MAGNETOCRYSTALLINE ANISOTROPY OF TWO YTTRIUM–COBALT COMPOUNDS. Hoffer, G.; Strnat, K. (Air Force Materials Lab., Dayton, Ohio). J. Appl. Phys., 38: 1377-8(Mar. 1, 1967).

The magnetocrystalline constants of two ferromagnetic rare earth–cobalt intermetallic compounds, YCo_5 and Y_2Co_{17}, have been measured in the approximate temperature range 20 to 300°K. The anisotropy constants were obtained from magnetization vs applied-field curves measured on single-crystal spheres in the principal crystallographic directions of the hexagonal structure. YCo_5 has a magnetically easy c axis and no anisotropy in the hard basal plane. K_1 increases from 7.03×10^6 erg/g at 300°K to 10.03×10^6 erg/g at 24°K. Y_2Co_{17} has an easy basal plane with no anisotropy in the plane. At 307°K, $K_1 = -3.61 \times 10^5$ erg/g, and $K_2 = 0.22 \times 10^5$ erg/g while at 21°K, $K_1 = -6.99 \times 10^5$ erg/g and $K_2 = -0.69 \times 10^5$ erg/g. (auth)

20515 BASAL-PLANE ANISOTROPY OF GADOLINIUM. Graham, C. D. Jr. (General Electric Co., Schenectady, N. Y.). J. Appl. Phys., 38: 1375-6(Mar. 1, 1967).

The magnetocrystalline anisotropy in the basal plane of gadolinium (constant K_4 in the usual notation) has been determined from torque measurements on a single-crystal disk in the temperature range 4.2° to 150°K. The easy direction in the basal plane is $\langle 11\bar{2}0 \rangle$, corresponding to $K_4 < 0$. The use of anisotropy per unit mass instead of the customary anisotropy per unit volume is suggested for measurements that extend over a range of temperature, and the symbol $\mathcal{K}_n$ is suggested for anisotropy-per-unit

mass. The value of $\mathcal{H}_4$ for Gd at 4.2°K is −800 erg/g, and $\mathcal{H}_4$ approaches zero at about 170°K. The temperature dependence of $\mathcal{H}_4$ follows approximately the 21st power of the magnetization as predicted by theory. (auth)

20516 BASIS FOR SOME OF THE VARIETY OF MAGNETIC PROPERTIES OF THE HEAVY RARE-EARTH METALS AND ALLOYS. Wollan, E. O. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 38: 1371-2(Mar. 1, 1967).

A molecular field analysis has been made for the TbY alloy system, and the results relative to the initial magnetic ordering properties are discussed in terms of their implication for the heavy rare earth metals and for alloys with Y, Sc, and La. The results indicate that the similarities and differences in these magnetic systems can be closely correlated with the crystal parameters that determine the distances between magnetic atoms in a particular metal or alloy. Ordering temperature changes that result from atomic size effect and pressure-induced volume changes are compared and found to agree. Transition temperatures for alloys for which the axial ratios and atomic volumes are held constant are found to vary linearly with the effective spin variable. The overall results are found to be qualitatively consistent with an RKKY type of interaction. (auth)

20517 FERROMAGNETISM AND SUPERCONDUCTIVITY IN $TiFe_xCo_{1-x}$. DeSavage, B. F.; Goff, J. F. (Naval Ordnance Lab., Silver Spring, Md.). J. Appl. Phys., 38: 1337-8(Mar. 1, 1967).

The magnetization and transport properties have been studied in the intermetallic system $TiFe_xCo_{1-x}$, where $0 \leq x \leq 1$. The composition x = 0.5 is superconducting while all other alloys within the composition range $0.3 < x < 0.7$ are ferromagnetic. Below the ferromagnetic transition temperature, alloys with $0.5 < x < 0.7$ exhibit conventional field dependences, saturating at 2 kOe with a moment of the order of 10 emu/g. Alloys with $0.3 < x < 0.5$ do not saturate in fields of less than 25 kOe. The magnetization of the alloy with x = 0.5 is nearly linear in field and no Curie temperature is observed. The magnitude of the magnetization is lower than neighboring compositions by a factor of four. The composition range of this behavior is very narrow, as alloys with x = 0.55 and x = 0.45 are ferromagnetic Compositions with $x < 0.3$ and $x > 0.7$ are not ferromagnetic but exhibit paramagnetism presumably due to conduction electrons. The residual electrical resistivity appears to follow Nordheim's rule, suggesting disordered alloys, including the x = 0.5 composition. The alloy x = 0.5 has a superconducting transition temperature of 3.3°K, all other compositions within $0.3 < x < 0.7$ not being superconductors. The low-temperature ideal resistivity is found to vary as T^2, but near the composition x = 0.5 the temperature dependence differs from T^2. This is taken to be a result of multiband deviations from Matthiessen's rule. The implication is that the superconductivity is associated with only a portion of the Fermi surface. (auth)

20518 MAGNETIC PROPERTIES OF $PrAl_2$. Olsen, C. E.; Arnold, G.; Nereson, N. (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 38: 1395-6(Mar. 1, 1967).

Neutron-diffraction powder patterns have confirmed that the compound $PrAl_2$ undergoes a magnetic transition to a ferromagnetic structure at a Curie temperature of 38°K. The ordered moment at saturation on the Pr atom sites is $2.94 \pm 0.05\ \mu_B$, which is close to the full moment of $3.2\ \mu_B$ expected for the free Pr^{+3} ion. No detectable moment is observed for Al. The present results for the total moment per molecule are in satisfactory agreement with previous magnetization measurements. The shape of the magnetic form factor for the Pr^{3+} ion was determined over the range from $(\sin\theta)/\lambda = 0.1$ to 0.5 $Å^{-1}$ and is in good agreement with calculated values. (auth)

20519 WORK HARDENING AND DISLOCATION STRUCTURE IN Ta AND Ta-BASE ALLOYS. Arsenault, R. J. (Oak Ridge National Lab., Tenn.); Lawley, A. Contract W-7405-eng-26. Phil. Mag. (8), 15: 549-65(Mar. 1967). (ORNL-P-2206).

The work-hardening characteristics of Ta and Ta-base alloy single crystals were investigated as a function of temperature, orientation, and interstitial concentration; associated dislocation structures were characterized parallel and perpendicular to the primary slip vector. The presence or absence of stage II hardening was related to the magnitude of the effective stress τ^*. When $\tau^* \simeq 0$, stage II hardening occurred and the work-hardening slope θ_{II} was a maximum. As τ^* increased, θ_{II} decreased and in the limit only stage I was observed. In comparison with fcc metals, there was a large degree of overshoot (~10°), and it appears that secondary slip is a necessary condition for the existence of stage II hardening. An explanation for the dependency of stage II and the magnitude of θ_{II} on the level of τ^* is advanced, based on two factors: the probability of the stable reaction $a/2[11\bar{1}] + a/2[1\bar{1}1] = a[100]$ occurring increases with decreasing τ^*; and the increase in internal stress required for secondary slip is lower at small effective stresses. These concepts are shown to be consistent with the associated structures. Increasing the solute concentration either eliminated the three stages of work hardening or reduced the rate of work hardening in stage II. Interstitial impurities locked the grown-in dislocations and/or led to precipitates; both give rise to barriers, and induce secondary slip at low strains with an associated parabolic form of stress-strain curve. Similarly, substitutional atoms can lock the grown-in dislocations, such that these act as barriers (e.g., W additions), or reduce the number of operative sources on secondary slip systems (e.g., Nb additions). (auth)

Structure and Phase Studies

Refer also to abstract 20490.

20520 (TID-22457) ISOTHERMAL PHASE TRANSFORMATIONS IN CERIUM METAL AT 80°K. Major, R. W.; Millhouse, A. H.; Leinhardt, T. E. (Virginia Polytechnic Inst., Blacksburg. Dept. of Physics). [1962]. Contract AT(40-1)-2689. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Isothermal phase transformations in Ce at 80°K were made by simultaneous x-ray diffraction and electrical measurement. The results are presented in graphic form. (P.C.H.)

20521 ALLOY THEORY DESCRIPTION OF TRANSITION METALS: THE BAND SHIFT EFFECT. Beeby, J. L. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 90: 779-86(Mar. 1967).

The band-shift effect is discussed from the point of view of alloy theory. The case of an alloy in which the bandwidth is small compared with differences in binding energy is closely similar to the strong correlation limit. The alloy is treated by t-matrix theory and it is shown how previous work may be improved to give the correct behavior for the band-shift effect. This requires first a description of tight-binding theory as derived from the t-matrix formalism and then the extension of the treatment to include correctly all double-hopping terms in the summation. (auth)

20522 INTERMETALLIC PHASES IN THE SYSTEMS OF ZINC WITH LANTHANUM, CERIUM, PRASEODYMIUM, NEODYMIUM, AND YTTRIUM. Veleckis, Ewald; Schablaske, Robert V.; Johnson, Irving; Feder, Harold M. (Argonne National Lab., Ill.). Trans. Met. Soc. AIME, 239: 58-63(Jan. 1967).

The stoichiometry, structure, and stability of the intermediate phases formed between Zn and some of the rare earth (RE) metals were systematically examined by means of a recording effusion balance and x-ray diffraction analyses. In the La–, Ce–, Pr–, Nd–, and Y–Zn systems, at or below about 600°C, the following sequences of phases ($REZn_x$) were found: La, x = 1, 2, 4.0, 5.2_5, 7.3, 17/2,* 11, and 13.0;* Ce, x = 1, 2, 3, 11/3, 4.3, 5.2_5, 7.0, 17/2,* and 11; Pr, x = 1, 2, 3,* 11/3,* 4.3, 5.3(?), 7.0, 17/2,* and 11; Nd, x = 1, 2, 3,* 11/3,* 4.3, 6.5, 8.5,* and 11;* Y, x = 1, 2, 3, 11/3, 4.5, 5.0, 17/2,* and 12.* The structure types of all these phases were classified. In addition, lattice parameters were obtained for the first time for the phases denoted by asterisks. In the absence of detectable valency or electronegativity effects the systematic trends in the results were ascribed to the effects of lanthanide contraction. For example, the maximum number of Zn atoms in the coordination polyhedron surrounding the rare earth atom decreases from 24 to 22 to 20 as the size of the rare earth atom decreases. (auth)

20523 CRYSTAL STRUCTURE-GROUP NUMBER CORRELATION IN THE FIFTH- AND SIXTH-PERIOD LATTER TRANSITION METALS AND ALLOYS. Rudman, P. S. (Battelle Memorial Inst., Columbus, Ohio). Contract Nonr-5052(00), NR 039-089. Trans. Met. Soc. AIME, 239: 64-7(Jan. 1967).

Crystal-structure occurrences in binary phase diagrams of fifth- and sixth-period elements, Zr through Pd and Hf through Pt, are surveyed with the conclusion that average group number (GN) is the dominant correlative. This is interpreted in terms of curves of enthalpy differences between competitive structures that are continuous functions of GN. Absolute formation energies may also be continuous functions of GN and if so can be simply obtained from the negatives of the heats of sublimation of the elements. It is shown that from such a heat of formation-GN plot the heats of mixing of alloy systems can be quantitatively predicted. For example, for sixth-period alloys very large exothermic heats of mixing are predicted for systems that span GN = 6 (i.e., Hf–Pt, Ta–Os, . . .). Thermodynamic data with which to test these predictions were not available. (auth)

20524 LAMELLAR STRUCTURE OF MOLYBDENUM. Vrublevskaya, Z. V.; Orlov, L. G. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Fiz. Metal. Metalloved., 22: 286-9(Aug. 1966). (In Russian).

The dislocation structure of cold-rolled Mo (containing about 0.1% Zr and 0.2% Ti) has been investigated by microscopy. Cold-rolled Mo sheet 0.1 mm thick was reduced to a foil by electrolytic polishing in a 90% solution of H_2SO_4. The structure of cold-rolled Mo was made up to subgrains, mostly of elongated shape, separated from each other by dislocation walls or networks. The dislocation density within subgrains was relatively low. In addition to the usual structure of cold-rolled metals, there were some extended structural formations resembling grain or subgrain boundaries. These formations are assumed to be boundaries located in a plane parallel to the original sheet which divide the foil into parallel layers. This structure is probably responsible for the lower values of mechanical properties in the direction perpendicular to the direction of rolling. When even small stresses are applied, the foil splits into layers. (ATD)

20525 SURFACE MICRORELIEF OF BERYLLIUM CONDENSATES. Palatnik, L. S.; Fedorenko, A. I. (Kharkov Polytechnic Inst.). Fiz. Metal. Metalloved., 22: 936-8(Dec. 1966). (In Russian).

Since the surface structure of crystals is determined by their growth kinetics, it was of interest to investigate the surface microrelief of Be condensates with the aid of an UEMV-100 electron microscope to elucidate the effect of conditions of deposition (substrate temperature T_s, deposition rate ω_k and the angle φ of incidence of the molecular beam) on their structure and growth mechanism. For $T_s = \sim 120$ to $\sim 700°C$, φ from 0 to 50°C, ω_k = 5 to 300 Å/sec and thickness h of Be films = 0.5 to 100 μ, it was found that the surface relief of Be films is greatly affected by T_s. For $\sim 220°C < T < \sim 350°C$, well-developed forms of laminar-spiral crystal growth are observed on the surface of Be condensates with h > 10 μ; this mosaic relief is due to the striving of the film toward a minimal surface energy, and it disappears when $T_s < \sim 200°C$ owing to the shortening of the migration path of the condensing atoms. When $T_s > \sim 350°C$ this mosaic relief likewise fades, this time owing to the intensification of diffusion processes at the film surface. This mosaic relief makes it possible to determine the dimensions and orientation of crystals and the degree of random orientation between adjacent grains, i.e., characteristics which play an important role in the physical properties of films. As for the variation of φ, it does not markedly affect the surface microrelief of Be films. As regards ω_k, it is established that lamellar hexahedral crystals begin to grow at the film surface above a certain substrate temperature $T_{s.k.}$ which is a function of ω_k, and which decreases with increase in ω_k. E.g., when ω_k = 140 Å/sec, $T_{s.k.} \approx 500°C$ and when ω_k = 270 Å/sec, $T_{s.k.} \approx 300°C$. With the aid of microdiffraction it is established that these lamellar crystals represent regular Be monocrystals with a highly perfect crystal lattice due to the reversibility of condensation processes (extensive re-evaporation of Be atoms when $T_s > \sim 300°C$), which provides the conditions for rapid correction of defects in the crystalline structure of these monocrystals. Considering the distinctness of mosaic relief on the surface of Be films, it may be assumed that these lamellar hexahedral monocrystals of Be, forming on condensation of its vapors in the presence of considerable supersaturations ($\omega_k \approx$ 100–300 Å/sec and $T_s \approx 300-600°C$) represent the realization of the case where a layer hangs suspended above the crystal surface. The existence of an "atmosphere" of condensing atoms above the film surface apparently is a prerequisite for the formation of lamellar monocrystals and accounts for their absence when $T_s < \sim 300°C$. In conclusion, it should be noted that the surface relief of Be films points to a primarily laminar growth mechanism of condensates, with growth spirals being rarely encountered. (ATD)

20526 EFFECT OF OXYGEN ON RECRYSTALLIZATION OF TANTALUM. Gavrilyuk, M. I.; Konstantinov, V. A. Fiz. Metal. Metalloved., 22: 410-14(Sept. 1966). (In Russian).

To investigate the effect of oxygen on recrystallization temperature of high-purity Ta, electron-beam melted ingots of 99.362%-pure Ta containing 0.0007% O_2 were cold forged and rolled into 1.0 mm sheets after which the O_2 content increased to 0.1%. Annealing in air at 500°C for 5 or 10 hr followed by homogenizing annealing at 1200°C in a vacuum, increased the O_2 content to 0.4 or 0.7% respectively, which was below the limit of O_2 solubility of Ta at 20°C. The sheets were then cold rolled with a reduction of 50% and vacuum annealed at 800 to 2000°C for 1 hr. The recrystallization temperature of O_2-poor and O_2-rich Ta as determined by x-ray diffraction pattern examination and by hardness measurements was 1200°C regardless of the O_2 content. Annealing at temperatures above 1200°C and below 1600°C brought about no noticeable changes in hardness. However, annealing at 1800°C lowered the hardness in direct proportion to the initial O_2 content to roughly the same value. Thus, after annealing at 1800°C, the O_2-rich and O_2-poor Ta have the same microhardness and also the same lattice parameters. This appears to indicate that the embrittlement of recrystallized Ta, Mo, W, and Cr is brought about not by interstitial, but by substitutional elements. (ATD)

20527 ORIENTATION, PURITY, AND PERFECTION OF MOLYBDENUM SINGLE CRYSTALS GROWN BY ELECTRON-BEAM ZONE MELTING. Esin, V. O.; Levit, V. I.; Romanov, E. P.; Smirnov, L. V. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved., 22: 415-19(Sept. 1966). (In Russian).

Mo single crystals, 3 mm in diameter and 60 to 120 mm long, were grown by the zone-melting method in a vacuum of 10^{-6} to 10^{-7} mm Hg with an electron-beam heat source. The initial material, polycrystalline commercial-grade (99.8%-pure) Mo wire, had a ratio of resistivities at 285 and 4.2 K equal to 20. The orientations of the single crystals were found to depend on the rate of growing or on the rate of molten zone travel. No clear relationship was established between the single crystal perfection (the maximum disorientation angle between the elements of macromosaic substructure, maxθ') and the melting-zone speed at which the crystals were grown. A clear relationship, however, was found between the crystal perfection (maxθ') and its purity ($\rho_{285K}/\rho_{4.2K}$). The relationship can be empirically expressed as: the more perfect the crystal, the less pure it is. Increasing the zone refining effectiveness increased the angle of general disorientation of the fragments of macromosaic substructure of the crystals. Very pure Mo single crystals were obtained after three passes at medium speeds (1.2 to 1.8 mm/min). The maximum value of the $\rho_{285K}/\rho_{4.2K}$ ratio was 5000. The respective values for 2 passes and 1 pass were 2200 and 980. (ATD)

20528 CONSTITUTION OF NIOBIUM–COBALT ALLOYS. Pargeter, J. K.; Hume-Rothery, W. (Oxford Univ.). J. Less-Common Metals, 12: 366-74(May 1967).

The equilibrium diagram of the system Nb–Co was determined by a combination of thermal analysis, microscopical metallography, and x-ray diffraction techniques. The freezing point of Co was lowered markedly on addition of Nb, and the liquidus curves sank to a eutectic point at 13.9 at.% Nb and 1237°C. The constituents of the eutectic are a solid solution of Nb in Co (5.5 at.% Nb), and an $NbCo_3$-phase whose structure is based on that of the Laves C36 type. This decomposes peritectically at 1247°C to form liquid plus a "Co_2Nb" phase whose composition extends from 27 to 33.3 at.% Nb and whose structure is of the Laves C15 type. This gives rise to a maximum on the liquidus curve, and forms a eutectic with a phase denoted μ, which exists over the range from 50.5 to 52.7 at.% Nb, and whose structure is that of the W_6Fe_7 type. The μ phase gives rise to a flat maximum on the liquidus curve, surrounded by ($NbCo_3$ + μ) and (μ + Nb solid solution) eutectics. The maximum solubility of Co in solid Nb is 3.1 at.% at the 1374°C eutectic temperature. The significance of these results is discussed. (auth)

20529 RARE EARTH–Sb AND –Bi COMPOUNDS WITH THE Gd_4Bi_3 (anti-Th_3P_4) STRUCTURE. Gambino, R. J. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Less-Common Metals, 12: 344-52(May 1967).

The crystal structures of the 4:3 stoichiometry compositions in the rare earth–Sb and Bi systems were studied. The Gd_4Bi_3 (anti-Th_3P_4) structure was formed only by the lighter elements, La to Dy. This structure was only observed for compounds with radius ratios, based on ionic radii, between 0.417 and 0.520. The lattice constants of most of these compounds are linearly dependent on the trivalent ionic radii of the rare earths. Deviations from this linear dependence were observed for compounds containing Eu, Sm, and Yb, which suggest that these elements are, at least partly, in the divalent state. (auth)

20530 ZINC-RICH PHASES OF THE RARE EARTH–ZINC ALLOYS. Iandelli, A.; Palenzona, A. (Univ. of Genoa). J. Less-Common Metals, 12: 333-43(May 1967).

The crystal structures of intermetallic compounds in the composition range from 89 to 100% at.% zinc were investigated for the rare earth (RE) – Zn systems. Five crystal structure types were found, corresponding to the formulas: $REZn_{13}$, $REZn_{12}$, $REZn_{11}$, and RE_2Zn_{17}. The existence of the different structures appears to be closely related to the dimensions of the RE atoms. Eu and Yb behave as divalent elements. (auth)

20531 STUDY OF TEXTURES ARISING IN ELECTROLYTICALLY PRODUCED URANIUM BY ROLLING AT ROOM TEMPERATURE AND OF THEIR DEVELOPMENT DURING ANNEALING OF THE α PHASE. Jayne, G.; Cizeron, G.; Lacombe, P.

(Ecole des Mines, Paris. INSTN-CEN, Saclay, France). Mem. Sci. Rev. Met., 64: 66-76(Jan. 1967). (In French).

Work-hardened and recrystallized textures of α-U were determined quantitatively by the Schulz-Siemens method. (auth)

20532 ELECTRONIC STRUCTURE OF ALLOYS OF Nb-Zr SYSTEM. Korsunskii, M. I.; Genkin, Ya. E.; Omarov, M. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 82-5(Feb. 1967). (In Russian).

The shape of the last emissive Nb bands differed from that of the corresponding Zr bands in alloys of the Nb-Zr system and of the bands of pure Nb and pure Zr. It testifies to the incorrectness of the notion of a rigid N(E)-band. In the last emissive bands only their short-wave parts, which are interpreted in operation as a reflection of states of electrons, collectivized in alloys, proved to be similar in shape. The long-wave parts of the bands are interpreted as a reflection of states of electrons, taking part in local connections between Nb and Zr. The connections between Nb-Nb and Zr-Zr are reflected even more by long-wave maxima of very weak intensity. (auth)

Radiation Effects

Refer also to abstract 20591.

20533 (CONF-660511-, pp 7.3.1-5) IRRADIATION EFFECTS ON THERMOCOUPLES. Helm, J. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The effects of neutron exposure on the calibration of thermocouples are discussed. Irradiation temperatures varied from 400 to 1200°C and neutron exposures extended to 4×10^{21} nvt, E > 0.18 MeV. Extensive data were obtained on Geminol N-Geminol P and Pt vs Pt-Rh thermocouples. The calibration error was larger for the platinum thermocouples, 16% rather than 5%. (M.C.G.)

20534 (CONF-660511-, pp 7.5.1-6) THERMOCOUPLE DEVELOPMENT FOR USE IN MEASURING OXIDE FUEL TEMPERATURES IN-PILE ABOVE 4000°F. Novak, P. E.; Asamoto, R. R. (General Electric Co., San Jose, Calif.).

Investigations are under way to determine the performance of W-3Re/W-25Re and W-5Re/W-26Re thermocouples up to 4700°F for up to 1800 hours in $(Pu,U)O_2$ fuel. Bare wire thermocouples were calibrated up to 5400°F and ThO_2-insulated, W-26Re sheathed thermocouples were calibrated to 5100°F. The compatibility of W-26Re and Ta with mixed oxide was studied up to 4700°F. (auth)

20535 (CONF-660511-, pp 3.4.1-19) CONTROLLED TEMPERATURE-PRESSURE IRRADIATION CAPSULES. Leggett, R. D.; Hann, C. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The controlled-temperature and controlled-pressure, NaK-filled irradiation capsules developed at the Pacific Northwest Laboratories in conjunction with a program designed to study the basic mechanisms of the swelling (increase in volume) that occurs during the irradiation of fissionable and fertile metallic fuels are described. These capsules are used to study the effects of temperature; external restraint; specimen composition, structure, and geometry; burnup; and burnup rate on the behavior of metallic fuel specimens during irradiation. Physical descriptions of the capsules, which have a controlled temperature range of 200 to 800°C and a controlled pressure range of 30 to 5000 psi, are provided. A brief discussion is included on the design of the pressure shell, a weld configuration used, and the effects of high pressure helium on heat transfer. The high-integrity components, the extreme care exercised during construction, and the improved instrumentation provided a successful irradiation device for studying the behavior of fissionable materials. Very few thermocouple or heater failures occurred and no capsule incurred general failure. (auth)

20536 (CONF-660511-, pp 1.3.1-9) UNIQUE PROBLEMS AND SOLUTIONS ON GETR MATERIALS IRRADIATION CAPSULES. STRAIN CYCLE NO. 10 AND 11. Morissette, R. P.; Ogawa, S. Y. (General Electric Co., San Jose, Calif. Atomic Products Div.).

Design of material irradiation capsules for GETR strain cycle #10 and #11 is discussed. Strain cycle capsule #10 was designed to irradiate tubular fuel cladding materials at elevated temperatures. Details of the gas gap design and burst specimen design are given along with discussions of Al coating techniques and post-irradiation examination of strain cycle capsule #10. The proposed design of strain cycle capsule #11 for use in establishing strain cycle behavior of superheat cladding materials is also described. (J.R.D.)

20537 (CONF-660511-, pp 1.4.1-9) STEEL IRRADIATION CAPSULE AND RIG. Seki, Y.; Maekawa, T.; Mizuta, M.; Hirasawa, Y.; Kato, M.; Honda, Y. (Mitsubishi Atomic Power Industries, Inc., Omiya (Japan)); Ruston, W. R.; de Maere, G.; Muylaert, J.; Becriau, G. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)).

Rigs for the steel irradiation program in the BR-2 are described. For low-temperature irradiation the specimens were covered by an Al alloy clad. For high-temperature irradiation, γ heating in the irradiation channel was used. The irradiation rig consisted of the retractable and rotatable rig, the channel plug, and the pneumatic blocking mechanism. (M.C.G.)

20538 (CONF-660511-, pp 1.5.1-17) LIMITED TEMPERATURE AND FATIGUE TEST CAPSULE EXPERIMENTS. Haroldsen, F. O. (Idaho Nuclear Corp., Idaho Falls).

Two capsule designs and associated problems are reported. A splined-type Al tube was used to encapsulate ATR surveillance Be samples. A shrink fit was employed to ensure a good metal contact between the samples and the tube to ensure that the sample temperature did not exceed 120°C. The design allowed void space for gas release, and did not excessively constrain the growth of the sample. A comparison is made with a more standard stainless steel capsule, which indicates the effectiveness of the splined tube. A capsule for evaluating radiation effects on the fatigue properties of steels was designed, which permits cycling a specimen through an axial tension and compression cycle while in-reactor. The cycling can be controlled by the magnitude of stress or strain on the sample. Provisions were made to measure and record the stress, strain, hysteresis energy, and the number of cycles to failure. The capsule is single containment, which allows the more massive structural components to be cooled by reactor process water. The specimen train is temperature controlled and cooled with high purity He. The system was designed to hold to within 6°C of test temperature during reactor transients. (auth)

20539 (COO-1367-8) ELECTRON IRRADIATION HARDENING. Ono, Kanji; Meshii, M. (Northwestern Univ., Evanston, Ill. Dept. of Materials Science). Sept. 1965. Contract AT(11-1)-1367. 77p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Concrete mechanisms for the hardening due to irradiation below and above Stage I (liquid nitrogen temperature) recovery are presented along with a model for Stage I recovery which is consistent with the mechanical behavior of the specimen during that stage of recovery. Al single crystals were used in the experiments. The results at 23°K showed that dispersed interstitials are responsible for the observed effects. Only the theory of hardening based on the dispersed barrier model is consistent with various observations on the hardening effect of the irradiation at 23°K. Recovery of the hardening and appearance of the yield point phenomena due to annealing in Stage I are consistent with the established recovery mechanisms of the stage, that is, close pair recovery and free interstitial migration. It is postulated that the hardening effects of electron irradiation near 85°K are due to interstitials which have migrated to dislocations and precipitated into the form of jogs on the dislocations. (P.C.H.)

20540 REDISTRIBUTION OF IMPURITIES IN METALS DURING IRRADIATION AND RECOVERY. Berzina, I. G.; Savitskii, A. P. (Siberian Physical-Technical Inst., Tomsk, USSR). Fiz. Metal. Metalloved., 22: 789-91(Nov. 1966). (In Russian).

The effect of irradiation on the redistribution of impurities in metals has been evaluated from the rate of contact melting of Bi-Sn, Pb-Sn, and Cd-Sn pairs subjected to irradiation from an Ra-a-Be source. It was found that irradiation greatly increased the melting rate of irradiated pairs. However, within a few hours, the melting rate dropped sharply below the original value (prior to irradiation) and in 20 to 80 hr (depending on the metal pair) returned to an original value. Such behavior is assumed to be the result of the combined effect of irradiation-induced defects and impurities accumulated at grain boundaries. Freshly irradiated specimens contain a large quantity of defects which greatly increases the melting rate. Recovery lowers the number of defects and the melting rate. This assumption, however, does not account for the long period of time during which the melting rate remains at values lower than the original values. (ATD)

20541 EFFECT OF PLASTIC DEFORMATION ON BEHAVIOR OF NEUTRON-IRRADIATED METALS. Ibragimov, Sh. Sh. Fiz. Metal. Metalloved., 22: 318-20(Aug. 1966). (In Russian).

Annealed and cold-strained specimens of commercial grade Fe, Ni, and 1Kh15N15M2 austenitic steel were irradiated after various heat treatment with an integral flux of 6.8×10^{19} n/cm^2 at 70 to 100°C, and then tested for mechanical properties. The reduction with cold straining was 15 to 50% for Fe and Ni and 11 to 43% for steel specimens. Changes in the properties with irradiation were found to depend on the initial structure and conditions of metal. Plastic deformation noticeably reduced the metal sensitivity to

irradiation. Irradiation of the annealed iron increased the tensile strength from 24 to 25.5 kg/mm^2 (6.2%), the yield strength from 15 to 21.5 kg/mm^2 (43%), the microhardness from 90 to 120 kg/mm^2 (33%), and decreased elongation from 36.5 to 10.0% (72%). In cold-strained Fe, irradiation increased the tensile strength from 49 to 50.5 kg/mm^2 (3%), the yield strength from 45.5 to 47.5 kg/mm^2 (4.4%), the microhardness from 170.0 to 176.0 kg/mm^2 (3%), and decreased elongation from 4.2 to 3.3% (21%). The difference in the strength characteristics in Fe was noticeable at reductions below 15% and in Ni, above 15%. In austenitic steel, the relative irradiation-induced changes in the strength characteristics were roughly the same for both annealed and strained specimens. Annealing of strain-hardened specimens at temperatures up to 350°C had no appreciable effect on the irradiation-induced changes in the mechanical properties of Fe strained with a 50% reduction. But with annealing at 450°C, the changes in the strength characteristics became approximately the same as in nonstrained annealed iron. (ATD).

20542 THE SPECTRUM OF THE MAGNETIC AFTEREFFECT IN NEUTRON-IRRADIATED Ni SINGLE CRYSTALS. Seeger, A.; Walz, F.; Kronmueller, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Appl. Phys., 38: 1312-13 (Mar. 1, 1967).

The magnetic aftereffect of Ni single crystals following an irradiation of 10^{19} neutrons/cm^2 was investigated in the temperature interval between 90° and 400°K. In addition to small peaks, major relaxation peaks were observed at −125°C, −98°C, −79°C, and −28°C. Above 0°C some broad peaks are observed. An analysis of the disaccommodation shows that the relaxation peaks are due to single relaxation processes, the relaxation times of which depend on temperature through an Arrhenius equation. The relaxation peaks are attributed to the reorientation of point-defect clusters. A detailed analysis shows that the relaxation peak at −28°C is due to the reorientation of divacancies (orthorhombic symmetry). The relaxation above 0°C is the result of a diffusion of the divacancies within the domain walls. The low-temperature peaks are tentatively ascribed to the reorientation of trivacancies (trigonal symmetry) and other point-defect clusters, some of them possibly involving impurities. (auth)

20543 ENERGY DEPENDENCE OF MAGNETIC CHANGES INDUCED BY ELECTRON IRRADIATION. Gordon, D. I.; Sery, R. S. (Naval Ordnance Lab., Silver Spring, Md.). J. Appl. Phys., 38: 1331-2(Mar. 1, 1967).

Ten-mil-thick Supermalloy rings were irradiated at 110°C with electrons at energies of 0.5, 0.75, 1.0, 1.5, and 2 MeV. For each energy, doses ranged from 0.2 to 1.0 × 10^{17} electrons/cm^2. The data show that the energy threshold for producing magnetic changes is <0.5 MeV and extrapolation indicates it is ~0.4 MeV. Energy dependence of magnetic property changes above the threshold is steepest in the 0.5- to 1.0-MeV range, after which the slope of magnetic changes vs energy generally falls off. The particular pattern, however, is a function of dose and the presence or absence of magnetic field during irradiation. With no applied field, magnetization curves and remanence are depressed. The amount of depression increases with energy, beginning with a small change at 0.5 MeV, exhibiting large changes at 0.75 and 1.0 MeV, and tending to saturate at higher energies. Increases in coercive force show a similar energy dependence. However, with an applied orienting field during irradiation (radiomagnetic treatment) magnetization curves and remanence are elevated, rather than depressed. The elevation of B_r increases with energy up to about 1.0 MeV, above which this effect tends to saturate. Up to this energy, coercive force changes are relatively small. Above 1.0 MeV, large increases in coercive force result. Directional ordering through radiation-enhanced vacancy diffusion is used in interpreting these data. (auth)

20544 HYDROGEN EMBRITTLEMENT IN IRRADIATED STEELS. Rossin, A. D. (Argonne National Lab., Ill.); Blewitt, T. H.; Troiano, A. R. Nucl. Eng. Design, 4: 446-58(Dec. 1966).

Results of investigations to determine whether or not irradiated reactor pressure vessel steels become susceptible to hydrogen embrittlement are presented. Tests on 212-B irradiated to give a 35% increase in strength and a nil-ductility transition (NDT) temperature shift of 110°C showed the same relationship between delayed failure limits and notch tensile strength. Catastrophic embrittlement due to hydrogen (like delayed failures at 25 to 50% of the notch tensile strength in 4340) are not observed in 212-B steel, even for irradiated material and with the high hydrogen contents studied. Delayed failure behavior was similar to that observed in unirradiated material. Therefore, catastrophic hydrogen embrittlement of a well-designed nuclear reactor pressure vessel is not believed credible. (auth)

20545 FISSION FRAGMENT DAMAGE IN TUNGSTEN. Bowkett, K. M.; Chadderton, L. T.; Norden, H.; Ralph, B. (Cambridge Univ., Eng.). Phil. Mag. (8), 15: 415-21(Feb. 1967).

The study of fission fragment damage in tungsten by field-ion microscopy [Bowkett et al., Phil. Mag., 11: 651(1965)] was continued. Prepared specimens were bombarded with a collimated beam of fission fragments at a measured inclination to the specimen axis, giving results, which show that in small specimens a column of material can be pushed out along the fission fragment path. These findings lend support to the explanation advanced for the light contrast tracks observed by electron microscopy of thin foils that were irradiated with fission fragments [e.g., Bowden and Chadderton, Pro. Roy. Soc. A, 269: 143(1962)]. (auth)

20546 INFLUENCE OF REACTOR IRRADIATION AND OF THERMAL ANNEALING ON SOME STAINLESS STEELS. Motoc, C.; Teodorescu, I.; Znerea, I. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 11: 633-41(1966).

The reactor irradiation effects on the surface structure of some austenitic and martensitic steels were studied. The electron microscope technique associated with the replica method was used. The direct examination of irradiated specimens has not revealed essential surface changes. The annealing treatments performed in vacuum or in O_2 at 550 to 930°C during 6 to 8 hours have shown distinct differences between the structures of the nonirradiated and irradiated steels. These differences may occur as a result of surface migration of the steel constituents, which may produce also order–disorder phenomena. (auth)

20547 BEHAVIOR OF 9 PERCENT NICKEL STEEL IN A REACTOR ENVIRONMENT. Cowan, A.; Fearnehough, G. D.; Nichols, R. W. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Weld. J. (N. Y.), 46: 97s-104s(Mar. 1967).

Tests were made on 9% Ni steel to establish its suitability for use as a reactor pressure vessel material. Fabrication and welding aspects in the thick sections appeared satisfactory, although further development is necessary. However, both irradiation and thermal stability tests showed large increases in transition temperature. It is likely that, after a few years of operation at ≈300°C, the advantage (over a mild-steel vessel) of low transition temperature would be lost because of these large embrittling effects. (auth)

Ceramics and Cermets

Refer also to abstracts 20465, 20467, and 20468.

20548 PROCEEDINGS OF MEETING ON NUCLEAR AND ENGINEERING CERAMICS. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 1-459 (Feb. 1967). (CONF-651041).

Thirty papers were presented. Separate abstracts are prepared for 28 of these papers. Two papers were previously abstracted in NSA. For abstract numbers of individual papers see CONF-651041 in the Report Number Index. (UKAE)

For abstracts of individual papers see: 20553–20557, 20562–20567, 20577–20583, and 20596–20605.

Corrosion and Erosion

20549 GRAPHITE CORROSION AND CO_2 RADIOLYSIS IN LOOP EXPERIMENTS WITH HELIUM. Buerkholz, Armin; Kinsey, Denis. Nukleonik, 9: 69-76(Feb. 1967). (In German).

Results of experiments carried out in the BR-2 reactor with a gas loop are described. It is shown that CO_2 is radiolyzed by the reactor radiation with the greatest efficiency with transfer of the energy to the coolant gas. The corrosion of graphite can be described by the effect of atomic oxygen and the reaction constants calculated. The concentrations of CO and O were calculated. The G-value for CO production, the energy transfer, and the dissociation mechanism are discussed. (tr-auth)

Preparation and Fabrication

Refer also to abstracts 20478 and 20586.

20550 (BMI–1791) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING OCTOBER THROUGH DECEMBER 1966. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1967. Contract W-7405-eng-92. 96p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: (U,Pu)N fuel ma-

terials; irradiation effects in reactor cladding materials; coated-particle fuel materials; ceramic-coated Pu-base particle fuels; pyrolytic-carbon-coated UN; graphite coatings on fuel particles; UO_2-PuO_2 fuel development; and effects of high burnup on UO_2-CeO_2 and UO_2-ZrO fuels. (P.C.H.)

20551 (LA-DC-7562) SEMI-AUTOMATIC HOT-PRESSING. Cowan, Robert E. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The techniques and equipment described for semiautomatic hot pressing proved to be very satisfactory for preparing a wide variety of ferroelectric materials. Other materials may also be fabricated by this process. Approximately one hour is required for an operator to unload the furnaces and dies from a previous day's run and to prepare samples for the next hot-pressing operation. Only occasional checks are made throughout the day to ensure that the equipment is operating properly. This semiautomatic hot-pressing scheme resulted in substantial savings in man hours and yields a product having a high and uniform quality. (auth)

20552 PREPARATION OF SOLID SOLUTIONS OF SOME COMPLEX CARBIDES OF TRANSITION METALS. Denbnovetskaya, E. N. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 3, 32-7(Mar. 1967). (In Russian).

The alloys of Mo_3C_2-ZrC, Mo_3C_2-NbC, $WC-TiC$, $WC-ZrC$, $WC-HfC$, $WC-VC$, and $WC-TaC$ were prepared by the following methods of powder metallurgy: sintering, hot pressing, and synthesis in vacuum furnace. On the basis of cubic carbides the formation of wide-range solid solutions was confirmed in all systems. Concentration dependence of parameter of crystal lattice for all systems was investigated. (auth)

20553 PREPARATION OF URANIUM MONOCARBIDE OF CONTROLLED COMPOSITION BY CARBOTHERMIC REDUCTION OF THE OXIDES IN VACUUM. Williams, N. R. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 1-10(Feb. 1967). (AERE-R-5098).

The carbothermic reduction of UO_2 in vacuum was used to prepare UC suitable for the fabrication of near-stoichiometric dense carbide bodies with low O_2 (<0.1 wt %) and N_2 (<0.05 wt %) contents. Carbide feed material having known carbide contents in the range from 4.2 to 5.2 wt % can be provided to a predictable value ±0.05 wt % using the stable oxide U_3O_8 and vacuum-degassed graphite powders as raw materials. The latter are wet mixed and compacted for reacting at high temperature in a vacuum furnace. The temperature at which the reaction to carbide is carried out influences the composition of the product. According to choice of C content, corresponding O_2 contents may range between 0.7 and 0.01 wt % as the reaction temperature is varied from 1500 to 2000°C. The process developed is suitable for routine preparation on scales up to a 1-kg batch. (auth)

20554 DEVELOPMENT OF A PILOT PLANT FOR THE MANUFACTURE OF URANIUM MONOCARBIDE PELLETS. George, D. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 11-22(Feb. 1967). (AERE-R-5127).

A route is given for the production of 1 kg per day of UC pellets by the cold-pressing and sintering of finely-comminuted powder; equipment and manufacturing procedures are described in detail. (auth)

20555 FABRICATION OF URANIUM–PLUTONIUM MONOCARBIDE CERAMICS. Horspool, J. M.; Rose, N. F.; Finlayson, M. B. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Proc. Brit. Ceram. Soc., No. 7, 23-40(Feb. 1967).

Fine mixed carbide powders were prepared with a range of mean particle sizes, and the pressing and sintering characteristics were determined. Some correlation was found between sinterability and particle size distribution, but neither the mean particle size alone nor the surface area of the powders was significant. Several bonding agents were examined, with particular reference to the possible chemical reactions that could occur between the binder and the carbide during heat treatment. Examples of such reactions are carburization of carbide by paraffin waxes, and increase in C and O_2 contents brought about by polyethylene glycol binders. The influence of heating rates and furnace atmospheres on the nature and extent of these reactions was investigated. The influence of Ni on the debonding and sintering processes was established, and the marked changes produced in the microstructures of the mixed carbides are discussed. (auth)

20556 DISPERSION AND BREAKAGE OF COATED PARTICLES CONSOLIDATED IN A GRAPHITE MATRIX BY HOT PRESSING. Williams, G. H.; Morris, J. B.; Savage, D. W. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 41-60(Feb. 1967).

One type of fuel element suitable for use in a high-temperature gas-cooled nuclear reactor consists essentially of compacts containing a dispersion of coated-fuel particles embedded in a graphite matrix. For producing this type of compact a rapid hot-pressing process was developed. The effects of various parameters on the particle dispersion were examined. The most regular dispersion was achieved by the overcoating method of mixing. The damage suffered by coated particles was also investigated. The fractional failure of coatings during the mixing stage was negligible, about 0.5×10^{-4}, but during the subsequent hot pressing the factor rose to between 10×10^{-4} and 30×10^{-4}, according to the method of mixing. Failure of the coatings is probably due to friction at die walls during pressing or extraction of the compact. The provision of an unfueled zone surrounding the compacts reduced the damage factors to 5×10^{-4}, and further improvement is considered possible. (auth)

20557 PREPARATION AND FABRICATION OF URANIUM MONONITRIDE, PHOSPHIDE, AND SULPHIDE. Allbutt, M.; Junkison, A. R.; Carney, R. F. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 111-26(Feb. 1967). (AERE-R-4903).

Techniques for the preparation of 50- to 100-g batches of US, UN, and UP by reaction of U metal with H_2S, N_2, and PH_3 respectively, are described. The formation of UP by reaction of UO_2, C, and PH_3 was demonstrated. Methods of chemical analysis were developed, which show as-prepared US, UN, and UP to have a narrow range of homogeneity. Oxygen impurities occur in US as the oxysulfide UOS and in UN and UP as the oxide UO_2. Cold pressing and vacuum sintering of US is facilitated by a eutectic between US and UOS, melting point ~1700°C; vacuum sintering of UP above 1800°C can lead to liquid-phase sintering through the agency of free U metal. Maximum densities of 92 to 94, 84, and 89% of theoretical were obtained for US, UN, and UP, respectively, by cold pressing and sintering. Arc-melting of US gave ingots of >98% theoretical density; UP and UN both decomposed to free metal below their melting points. A hot-pressing technique is described, which gave densities better than 95% of theoretical for all three compounds. (auth)

20558 METHODS FOR METALLOGRAPHIC PREPARATION OF UO_2 AND UO_2CeO_2. Huenlich, Arnold. Prakt. Metallog., 4: 118-20(Mar. 1967).

UO_2 and UO_2-CeO_2 were wet-ground using 240- to 600-SiC emery papers after annealing in a sharp-temperature gradient. Single-grain surfaces from dark to light grey were observed, which disappeared after polishing. A mechanical-chemical method proved most suitable for polishing UO_2, UO_2-CeO_2, and UO_2-Mo cermets; purely mechanical or electrochemical methods were excluded because of the great hardness and the poor electrical conductivity of oxide ceramics. A solution of H_2O_2 and H_2SO_4 at room temperature was effective for etching grain boundaries and possible precipitations. (P.C.S.)

Properties Evaluations

Refer also to abstracts 20510, 20550, 20576, and 21718.

20559 (BMwF-FBK-66-32) VERHALTEN VON KERNREAKTORBRENNSTOFFEN BEI HOEHEREN TEMPERATUREN. (High-Temperature Performance of Nuclear Reactor Fuel Materials). Lindner, R. (Technische Hochschule, Brunswick (West Germany). Institut fuer Kern- und Radiochemie). June 30, 1966. 24p. (In German). Dep. mn.

Within the scope of a long range applied research program on nuclear materials, special efforts are being made to elucidate the transport mechanisms, essentially in high temperature nuclear fuels as UO_2 and UC. The program deals with self-diffusion measurements as well as fission product transport and release. In UO_2 activation energies between 90 and 110 kcals/mole have been found for the actinides and relationships between activation energy, ionic charge, and ionic radius tentatively established. As to fission products a strong dependence of diffusion on stoichiometric composition is observed but the large number of diffusion values do not yet fall into a consistent pattern. In UC at lower temperatures uranium transport proceeds with about 30 kcals/mole, at temperatures above 12 to 1500°C with about double that value and possibly at very high temperatures with about 100 kcals/mole. Compatibility of UO_2 with molten salts and molten sodium has been investigated and the release of some major fission products has been measured as well as the transport through sodium

to stainless steel and the adsorption and diffusion within this material. The latter process proceeds with activation energies of about 15 kcals/mole and may play an important role in the case of high burnup stainless steel-canned mixed oxide in fast breeders. (auth)

20560 (BNWL-SA-414) UN–PuN SOLID SOLUTION STUDIES. Weber, E. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 14, 1965. Contract AT(45-1)-1830. 5p. (CONF-651119-8). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Libby Cockcroft Information Exchange Meeting, Harwell, Eng.

X-ray diffraction patterns of heat treated UN–PuN displayed a single phase. Lattice parameters were determined. Compositions between 30 and 60 mole % PuN had slightly better definition of high angle reflections than samples of higher or lower PuN content, indicating better homogeneity in that range. Density changes of the pellets from the green to the fired state displayed an anomalous effect. A sharp increase in volume was noted for compositions in the middle to high PuN portion of the system. A carbothermic oxide reduction scheme for synthesis of mixed nitrides was attempted, using mechanically mixed and compacted powders of UO_2, PuO_2, and C. X-ray diffraction patterns of the product indicated a two-phase mixture of a somewhat inhomogeneous UN–PuN solution phase and a UO_2 phase. (P.C.H.)

20561 (CONF-651154-1) CAPSULE D'IRRADIATION CYRANO. ETUDE NUCLEAIRE ET THERMIQUE. RESULTATS DES PREMIERES MESURES EN PILE. (Irradiation Capsule Cyrano. Nuclear and Thermal Study. First Results of In-Pile Measurements). Berger, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov. 4, 1965. 25p. (In French). Dep. mn.

From Symposium on Flux Measurements used in Connection with Irradiation Equipment in Research and Material Test Reactors, Grenoble, France.

The Cyrano irradiation capsule designed for study of an unenriched UO_2 fuel is described. A nuclear study was made of the device. The specific nuclear power due to fission and to reactor γ rays and (n,γ) reaction was calculated. The results are tabulated and the methods of calculation are appended. Calorimetric measurements were made on a thermal mockup. Measurements of the total heat flux with the resistance probe led to evaluation of the P_N/P_M ratio of 1.57 ± 0.017. The measurement of the local heat flux in the central zone using a thermocouple gave a value for this ratio of 1.013 ± 0.018. The thermal conductivity of the steel wool thermal barrier was measured under He atmosphere as a function of the calorific power and under Ar to show the effect of the filling gas. The results of the first irradiation of the Cyrano capsule were compared with the calculated values. The agreement is very satisfactory. (J.S.R.)

20562 THE TECHNOLOGY AND ENGINEERING APPLICATIONS OF REACTION-BONDED Si_3N_4. Parr, N. L.; May, E. R. W (Admiralty Materials Lab., Dorset, Eng.). Proc. Brit. Ceram. Soc., No. 7, 81-98(Feb. 1967).

The use of reaction-bonded Si_3N_4 bodies as individual components, or in assemblies of ductile and brittle materials for engineering applications, is well established, but expansion of the technology was achieved. A possible explanation of the chemical and physical processes involved is presented. Recent experience in production methods, details of associated mechanical properties, and experimental applications aimed at establishing a design philosophy to exploit the properties of this material are described. (auth)

20563 HIGH-TEMPERATURE COMPRESSIVE CREEP AND HOT EXTRUSION OF URANIUM–CARBON ALLOYS. Magnier, P.; Marchal, M.; Accary, A. Proc. Brit. Ceram. Soc., No. 7, 141-58(Feb. 1967).

The high-temperature creep of U–C systems around the UC composition was studied. The behavior of these systems is strongly dependent on their total C content. The data obtained show that they can undergo very important plastic deformation, and die-forming at about 2200 to 2300°C is possible. X-ray investigation of extruded rods showed a preferential texture: UC(100) parallel to the extrusion direction. Die-forming can be extended to UC_2, ThC_2, and $(Th,U)C_2$. (auth)

20564 MEASUREMENTS OF SELF-DIFFUSION IN URANIUM CARBIDE AND THEIR APPLICATION TO RELATED ACTIVATED PROCESSES. Lee, Hee Myong; Barrett, L. R. (Imperial Coll. of Science and Technology, London). Proc. Brit. Ceram. Soc., No. 7, 159-76(Feb. 1967).

The self-diffusion parameters for C and U in stoichiometric and nonstoichiometric UC were measured by ^{14}C and ^{235}U in the range from 1260 to 1880°C by the standard sectioning technique. For stoichiometric UC the diffusion of C in the temperature range from 1266 to 1684°C can be represented by the equation $D = 1.75 \exp -(63,000 \pm 1,000)/(RT)$, and the diffusion of U in the temperature range from 1505 to 1863°C can be represented by the equation $D = 8.47 \exp -(104,000 \pm 7,000)/(RT)$. These results permit comparison with work on sintering, creep, and fission-gas release. The activation energy of bulk diffusion for U is in good agreement with that of the sintering kinetics (McLaren, Regan, and Hedger). From the results of Norreys and Wheeler, the mechanism for creep appears more complicated than that of Nabarro and Herring. (auth)

20565 THE EFFECT OF STRAIN RATE, ENVIRONMENT, AND SURFACE CONDITION ON THE MODULUS OF RUPTURE OF BERYLLIA. Rotsey, W. B.; Veevers, K.; McDonald, N. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, Australia). Proc. Brit. Ceram. Soc., No. 7, 205-20(Feb. 1967). (AAEC-TM-305).

The bend strength of dense fine-grained (3 μm) BeO was measured in the "machined" and "annealed" conditions at five strain rates in three environments (oil, air, and water) corresponding to atmospheres containing from 0 to 100% water vapor. The strength of the machined BeO was always significantly lower than that of the annealed, which is attributed to a high density of microcracks in the machined material. In environments containing water vapor the strength of BeO was significantly lower than when tested in the absence of water vapor. In the absence of water vapor, the strength of annealed BeO increased with increasing strain rate, whereas the machined BeO showed no strain-rate dependence. In the presence of water vapor a strain-rate dependence was observed for both surface conditions, which was more marked as the concentration of water vapor was increased. The results are discussed particularly with respect to crack nucleation, which is considered to depend on dislocation movement. (auth)

20566 THE PROPERTIES OF BeO CONTAINING UP TO 15 WT PERCENT SiC AND UP TO 2 WT PERCENT MgO. Hill, N. A.; O'Neill, J. S.; Livey, D. T. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 221-32(Feb. 1967). (AERE-R-5056).

A dispersion of sub-micron SiC particles in BeO containing 1 wt % MgO showed restricted grain growth during sintering. Compacts containing 8 wt % SiC sintered to a density of 2.94 g/cm^3 after 4 hr at 1750°C, with a mean grain diameter of 5 μm and a mean modulus of rupture in 3-point bending of 50,000 psi. The mean modulus of rupture was approximately proportional to the reciprocal of the square root of mean grain diameter. These results are compared with those from BeO without additions. (auth)

20567 DELAYED FRACTURE AND CREEP IN SILICON CARBIDE. Rumsey, J. C. V.; Roberts, A. L. (Univ. of Leeds, Eng.). Proc. Brit. Ceram. Soc., No. 7, 233-44(Feb. 1967).

The delayed fracture in air of a "self-bonded" SiC in the range from room temperature to 1200°C was studied. Measurements in the temperature range R.T. to 300°C, analyzed by a novel statistical technique, showed that "instantaneous" fracture stress S_0, applied stress S, and fracture time t are related by an equation $A(S_0 - S) = \log_e Bt$, A and B being constants at a given temperature. Experiments at higher temperatures are described, including 1200°C for times in excess of 1000 hr. A preliminary study showed that creep occurs at temperatures above 500°C. Long-term experiments at 1200°C revealed well-defined stages of primary and secondary creep. (auth)

20568 NEW POLISHING MATERIALS FOR PROCESSING OF SINGLE CRYSTALS. Artamonov, A. Ya.; Tutakov, O. V.; Daich, A. I. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 3, 38-41(Mar. 1967). (In Russian).

Polishing characteristics of some refractory compounds were investigated. Zirconium and titanium carbides and molybdenum, tungsten, and zirconium borides were found to have better polishing properties than synthetic diamonds, SiC or B_4C. They were successfully used in the polishing of semi-conductor materials, copper, and Cu-base alloys. (J.G.B.)

20569 NMR STUDIES OF MAGNETIC PROPERTIES OF LIGHT RARE-EARTH HYDRIDES. Kopp, J. P.; Schreiber, D. S. (Northwestern Univ., Evanston, Ill.). J. Appl. Phys., 38: 1373-5 (Mar. 1, 1967).

Measurements of the ^1H NMR line width and Knight shift have been made as functions of temperature and hydrogen concentration for CeH_x ($2 \leq x < 3$). Knight shifts of the order of +2.0% occur for $x = 2.45$ at $T = 6°K$ for which the line width is 160 G. The shifts and widths decrease as the concentration is decreased or increased

to 2.0 or 2.85, respectively. Calculations of the shifts are performed using the RKKY theory with the assumption of Weiss constants obtained from a linear fit to the reciprocal shift data. What appears to be a magnetic ordering occurs for the intermediate concentrations (T_N = 5.4°K for x = 2.45), as observed by the disappearance of the line. A simple overlapping, rigid-band model is proposed to explain the results. (auth)

20570 MAGNETIC PROPERTIES OF RARE-EARTH COMPOUNDS. Busch, G. (Swiss Federal Inst. of Tech., Zurich). J. Appl. Phys., 38: 1386-94(Mar. 1, 1967).

The magnetic properties of binary rare earth compounds are reviewed. The influence of crystal field and exchange interaction on the magnetic properties is shown to vary systematically in the group of LnX compounds [Ln = lanthanide atom, X = N, P, As, Sb]. Crystal-field parameters are calculated. The europium chalcogenides are of particular interest. From measurements of the magnetic susceptibility at normal and high pressure it is concluded that EuSe is antiferromagnetic above 3°K approximately with a Néel temperature of 4.6°K, but it assumes a ferro- or ferrimagnetic structure at lower temperatures. The optical absorption of EuO, EuS, EuSe, and EuTe was measured as a function of temperature. Energy gaps and their variation with temperature were determined. A giant decrease of the gaps was observed below the Curie and Néel temperatures, respectively. The change of the gaps is shown to be proportional to the magnetization of the specimen. This effect yields a new method to measure the spontaneous magnetization without a magnetic field. A long tail of the spontaneous magnetization above the Curie temperature is found. (auth)

20571 THE MAGNETIC SUSCEPTIBILITY OF NEPTUNIUM OXIDE AND CARBIDE BETWEEN 4.2 AND 350°K. Ross, J. W.; Lam, D. J. (Argonne National Lab., Ill.). J. Appl. Phys., 38: 1451-3(Mar. 1, 1967).

The magnetic susceptibilities of the NpO_2 and NpC have been measured from 4.2 to 350°K. The inverse susceptibility of NpO_2 is linear in temperature above 60°K with an effective paramagnetic moment of 2.95 μ_B. A peak in the susceptibility-vs-temperature curve is observed at 25°K, in agreement with the maximum observed in the specific heat of NpO_2. The NpC becomes ferromagnetic below 200°K. A peak in the susceptibility-vs-temperature curve at 310°K indicates a transition from a magnetically ordered arrangement to a paramagnetic one. The effective moment per NpC unit for the ferromagnetic and paramagnetic states is 1.4 μ_B and 3.37 μ_B, respectively. (auth)

20572 FAR-INFRARED SPIN-WAVE AND ANOMALOUS PHONON ABSORPTION IN ANTIFERROMAGNETIC URANIUM DIOXIDE. Allen, S. J. Jr. (Bell Telephone Labs., Murray Hill, N. J.). J. Appl. Phys., 38: 1478-9(Mar. 1, 1967).

The far-infrared spectral response of antiferromagnetic UO_2 has been studied between 10 and 220 cm^{-1} as a function of temperature, magnetic field, and uniaxial strain. In the ordered state, resonant absorption is observed at 17.5, 79.0, 99.0, 110.5, 184.0, and 216.0 cm^{-1}. The resonances at 79.0 cm^{-1} and 99.0 cm^{-1} are shown to be nondegenerate antiferromagnetic modes. Absorption by zone-boundary magnons within domain walls is believed responsible for the structure at 17.5 cm^{-1}. The remaining modes appear to be anomalous phonon absorptions, which appear in the ordered state by virtue of the strong magnon–phonon interaction. (auth)

20573 THERMAL CONDUCTIVITY AND FAR-INFRARED ABSORPTION OF UO_2. Aring, K.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y.). J. Appl. Phys., 38: 1496-8(Mar. 1, 1967).

The thermal conductivity of single-crystal UO_2 has been measured from liquid-helium temperature up to room temperature. The sample temperature was determined, with a helium gas bulb thermometer, and the temperature gradient was measured with Au–Co vs Manganin differential thermocouples. In the vicinity of the Néel temperature, T_N = 30.8°K, the conductivity is depressed by two orders of magnitude, from that expected for a similar diamagnetic crystal. The experimental results demonstrate that a strong phonon–magnon coupling exists in this crystal. The far-infrared transmission of the same UO_2 crystal has been measured from a frequency of 5 to 115 cm^{-1} at 3°K. A grating monochromator and a Strong-type lamellar interferometer have been used for these measurements. A sharp absorption line has been found at 17.63 ± 0.1 cm^{-1}. Broader absorption lines have been observed at 19.2, 23, 79, and 100 cm^{-1}. Transmission measurements in which a 50-kG magnetic field is applied to the sample or the sample temperature is varied indicate that impurity-induced absorptions occur at 19.2 and 23 cm^{-1}, and the three remaining lines can be identified with the antiferromagnetic state of UO_2. (auth)

20574 IMPREGNATED TANTALUM CARBIDE. Hivert, A. (ONERA, Chatillon-sous-Bagneux, France). Mem. Sci. Rev. Met., 64: 77-92(Jan. 1967). (In French).

Mechanical properties of TaC at high temperatures were studied. The processing of carbide with predetermined porosity and its impregnation are described. Survival of the carbide skeleton after impregnation and during use of the product is demonstrated. The beneficial effects of impregnation are discussed. (auth)

20575 ELECTRICAL PROPERTIES OF MELTS OF SiO_2–UO_2 SYSTEMS. Cojocaru, L. N. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 11: 593-9(1966).

The electrical conductivity and the thermoelectric power of melts of SiO_2–UO_2 systems, at temperatures between 300 and 900°K, have been studied. The electrical conductivity decreases with decreasing UO_2 content in the system from about 10^{-3} to 10^{-9} $\Omega^{-}cm^{-1}$, the thermoelectric power increases from 0.5 to 0.75 mV/°K with decreasing UO_2 content, and the activation energy increases from 0.3 to 1 eV with decreasing UO_2 content. The results can be interpreted on the basis of the hypothesis that the conductivity decrease is due to the decreasing number of U ions. (auth)

Structure and Phase Studies

Refer also to abstracts 20550 and 21334.

20576 (CEA-S-5) SPECULATION SUR IES DEFAUTS CRISTALLINS DANS UO_2 ET UO_{2+x}. (Some Speculations Concerning Crystal Defects in UO_2 and UO_{2+x}). Kingery, W. D. (Institut National des Sciences et Techniques Nucleaires, Paris (France). Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 19p. (In French). Dep. mn.

The crystal structure of UO_2 and UO_{2+x} was studied using thermodynamic, crystallographic, optical, and electric measurements. The hypotheses used in the study were: molecular oxygen solution; ionization of the oxygen with an activation energy of about 2 eV; association between the additional oxygen atoms in the range of high values of x; and dislocations, grain boundaries, and surface play an important role in dislocations. (P.C.H.)

20577 THE TEXTURE OF PYROLYTIC SILICON CARBIDE. Popper, P.; Riley, F. L. Proc. Brit. Ceram. Soc., No. 7, 99-110(Feb. 1967).

SiC was formed by thermal decomposition of methyltrichlorosilane on a graphite substrate at 1410°C. Hydrogen was used as a carrier gas. The texture of the deposit, which varied from grainless to large columnar grains, depended on the ratio of H_2/methyltrichlorosilane. If the flow of hydrogen is insufficient to sweep out the decomposition products, graphite or C-rich SiC might be deposited. The grainless deposits are prone to crack formation. (auth)

20578 EFFECTS OF NICKEL ON THE STRUCTURE OF SINTERED URANIUM CARBIDE. Eyre, B. L.; Bartlett, A. F. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 127-40(Feb. 1967). (AERE-R-5079).

Transmission electron microscopy was used to study the effects of Ni on the structure of Ar-sintered UC. The results were compared with optical microscope observations and electron probe micro-analysis measurements. U_2C_3 was identified directly by electron diffraction in specimens containing no Ni and 0.1 wt % Ni. There did not appear to be any particular orientation relationship between the UC matrix and U_2C_3. Electron-diffraction results from a second phase in the UC–0.5 wt % Ni specimens were consistent with UNi_2. The most easily observable effect of Ni on the structure of UC was the formation of bands containing periodic fringe contrast. The bands lay on {100} planes, and their behavior was consistent with a displacement vector of ½ ⟨113⟩. It is shown that these results are consistent with the bands being thin plates of $UNiC_2$, formed from the UC lattice by a heterogeneous shear transformation. (auth)

20579 COMPATIBILITY RELATIONSHIPS OF URANIUM CARBIDES WITH ALLOYS OF IRON, NICKEL, AND CHROMIUM. PHASE EQUILIBRIUM IN THE SYSTEMS U–Ni–C, UC–Fe–Cr, AND UC–Fe–Ni. Dutta, S. K.; White, J. (Univ. of Sheffield, Eng.). Proc. Brit. Ceram. Soc., No. 7, 177-204(Feb. 1967).

The stability relationships of uranium oxycarbides are discussed in the light of recent work on the system U–C–O, and the factors determining the oxygen contents of UC are indicated. Phase equilibrium relationships in the ternary U–Ni–C and in the pseudo-ternary systems UC–Fe–Ni and UC–Fe–Cr were investigated using a method based on the metallographic and x-ray examination of rapidly-cooled specimens. In the system U–Ni–C the existence

of the compound $UNiC_2$ was confirmed. This compound was found to melt incongruently and to have an extensive field of primary crystallization on the liquidus surface. The incompatibility of UC and Ni in the solid state was also confirmed. The section UC–Fe–Cr of the system U–Fe–Cr–C is unusual in that, while Fe and Cr are both compatible with UC in the solid state, over a wide range of compositions Fe–Cr solid solutions are incompatible since $Cr_{23}C_6$ and UFe_2 are formed according to the reaction $6UC + 23Cr + 12Fe = 6UFe_2 + Cr_{23}C_6$. The boundaries of the primary crystallization fields in this section were established, and the corresponding compatibility relationships in the quaternary system were deduced. In the section UC–Fe–Ni of the system U–Fe–Ni–C compatibility of UC with Fe–Ni alloys in the solid state is restricted to a narrow range of alloys containing 0 to 5% Ni approximately, due to the formation of $UNiC_2$ and UNi_5. The boundaries of the primary crystallization fields in the liquidus surface of the section were also established, and the corresponding compatibility relationship in the quaternary system deduced. (auth)

20580 GRAIN GROWTH IN UO_2. III. SOME FACTORS INFLUENCING EQUIAXED GRAIN GROWTH. MacEwan, J. R.; Hayashi, J. Proc. Brit. Ceram. Soc., No. 7, 245-72(Feb. 1967).

Under isothermal conditions, equiaxed grain growth proceeds in the classical manner as a function of time and temperature. The effect of five other potential variables was examined. Increasing the O/U ratio from 2.00 to 2.23, while retaining the fluorite structure, enhanced the rate of growth by up to four orders of magnitude. The activation energy was determined at $UO_{2.02}$ and was 60% of the value for $UO_{2.00}$. The application of a uniform stress, sufficient to cause plastic flow, did not affect growth, but a nonuniform stress caused exaggerated growth in the region of highest stress. Addition of a solute impurity, 0.77 mole % CaO, decreased the rate of growth below 2400°C and increased the activation energy by 25%. Irradiation exposure in a nuclear reactor was found to inhibit growth severely. The application of the Zener relationship to a particular sinter, for which the change in pore-size distribution was followed during grain growth, indicated that porosity elimination was not rate-controlling. (auth)

20581 COLUMNAR GRAIN GROWTH IN URANIUM DIOXIDE. Potter, T. J.; Elyard, C. A. (Associated Electrical Industries Ltd., Rugby, Eng.). Proc. Brit. Ceram. Soc., No. 7, 273-88 (Feb. 1967).

An arc-image furnace was employed to set up steep thermal gradients in ceramic UO_2 and the microstructural changes occurring at temperatures up to 2200°C were examined. This method of heating has the advantage that it avoids the possibility of any contamination of the UO_2 by metal from a heating-element, which might affect the grain-growth behavior. As was found by other workers, columnar grains are formed under gradient conditions at temperatures of 1800°C and above. The effect of metallic and oxide additions to the UO_2 on the formation of columnar grains was examined. Under the test conditions additions of metallic Ir and of Y_2O_3 inhibited the formation of columnar grains in UO_2. It was concluded that columnar grain growth involves both the presence of porosity and a diffusion mechanism. (auth)

20582 BEHAVIOR OF INERT GASES IN CERAMIC FUELS. Barnes, R. S.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 343-54(Feb. 1967).

The migration and coalescence of gas bubbles are invoked to evolve a model for the behavior of the fission-product gases Xe and Kr in UO_2 and UC fuel elements. The large temperature gradients, which are produced in ceramic fuels under irradiation, dominate bubble mobility. Dislocation lines and grain boundaries do not trap bubbles with radii sufficiently large to be dragged off by the gradient. The model predicts three distinct annular regions from the surface to the center of the fuel rod: where the gas is trapped in the grains; where the gas can accumulate at the grain boundaries; and where the gas is swept to the center of the rod during columnar grain growth. The behavior of gas bubbles in fuel rods of comparably sized UO_2 and UC fuel rods is discussed. (auth)

20583 MIGRATION OF KRYPTON BUBBLES IN URANIUM DIOXIDE. Cornell, R. M.; Bannister, G. H. (Berkeley Nuclear Labs., Eng.). Proc. Brit. Ceram. Soc., No. 7, 355-62(Feb. 1967).

Thin foils of UO_2 were bombarded with Kr^+ ions to a dose of 4×10^{15} ions/cm^2. Kr bubbles were produced by annealing, and identical areas were examined in the electron microscope before and after annealing. Random bubble migration was observed after isothermal annealing of these foils at 1500 and 1600°C. Preliminary results suggest that the root-mean-square distance migrated by the bubbles varies directly with bubble radius. This behavior is at variance with currently accepted models for bubble migration. (auth)

20584 INVESTIGATION OF EVAPORATION VELOCITIES OF URANIUM AND ZIRCONIUM CARBIDE CATHODES AND THEIR SOLID SOLUTIONS. Kul'varskaya, B. S. At. Energ. (USSR), 21: 368-75(Nov. 1966). (In Russian).

For investigation of the evaporation velocity of carbide thermocathodes, the Langmuir method was used in conjunction with the Becker method. Data were obtained on the evaporation rates of cathodes of ZrC, UC, and their solid solutions. It was established that the highest evaporation rate was possessed by UC and the lowest by ZrC; the solid solutions occupy an intermediate position. It was shown that the evaporation rates of the carbide cathodes depends on the cathode support. (tr-auth)

20585 Nd_2O_3–Cr_2O_3 SYSTEM. Pavlikov, V. N.; Tresvyatskii, S. G. Zh. Neorg. Khim., 11: 1442-5(1966). (In Russian).

The phase diagram of the $Nd_2O_3-Cr_2O_3$ system was studied in Ar at 1800 to 2500°C range. Samples varying in composition by 2 to 5 mol % were prepared by threefold fusing of powdered mixtures of Nd_2O_3 and Cr_2O_3 for 2 hrs at 1200°C. The structures of various samples were examined on the URS-55 x-ray machine and the temperatures were measured with an optical pyrometer OPPIR-O 17. It was found that only one compound, ($NbCrO_3$), existed in the $Nd_2O_3-Cr_2O_3$ system in the 1800 to 2500°C range. The $NbCrO_3$ has a melting point of 2330°C and a density of 8.08 ± 0.02 g/cm^3. $NbCrO_3$ was found to form one eutectic with Nd_2O_3, which is composed of 76 mol % Nd_2O_3 and 24 mol % Cr_2O_3 with a melting point of 2060 ± 30°C, and one eutetic with Cr_2O_3, which is composed of 78 mol % Cr_2O_3, and 22 mol % Nb_2O_3 with a melting point of 2100 ± 30°C. It was found that there are no phases in the $Nb_2O_3-Cr_2O_3$ system that contain divalent Cr. (ATD)

20586 TWO TERNARY OXYGEN COMPOUNDS OF RHENIUM AND VANADIUM. Freundlich, William; Lee, Marie-Renee (Univ., Paris). Compt. Rend., Ser. C, 264: 704-6(Feb. 20, 1967). (In French).

When an equimolar mixture of the oxides, Re_2O_7 and V_2O_5, was heated at 700° in a sealed SiO_2 tube under vacuum and tempered above 450°, a red compound $VReO_5$, was formed. A green compound of composition $VReO_{5,5}$ was formed by slow cooling the same mixture or by the direct action of Re_2O_7 on VO_2. The green compound formed two hydrates and 1 and 3,5 H_2O molecules. The anhydrous phase crystallized from the orthorhombic system, in the space group C mc 2_1 or C mcm. The parameters are: a = 5.68 Å, b = 14.65 Å, c = 8.83 Å. (tr-auth)

20587 BURGERS VECTOR OF DISLOCATION LOOPS IN GRAPHITE. Thrower, P. A. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag. (8), 15: 607-15(Mar. 1967). (AERE-R-5296).

Dislocation loops in graphite were observed in both unsheared and sheared orientations. A mechanism involving cleavage of the material for electron-microscope examination is given to explain the observed characteristics of sheared loops. It was concluded that the 'A over A' stacking-fault energy is 38 ergs cm^{-2}, and that the lattice strains around vacancy loops of radius <100 Å are not characteristic of perfect dislocation loops. (auth)

20588 THE INTERACTION BETWEEN DISLOCATION LOOPS AND STRAIGHT DISLOCATIONS IN AN ANISOTROPIC MATERIAL, GRAPHITE. Thrower, P. A. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag. (8), 15: 341-52(Feb. 1967). (AERE-R-5271).

The elastic interaction between dislocation loops and straight dislocations in orthotropic, anisotropic materials was studied for the three configurations that occur in graphite. The total-interaction energy and total force between the interacting elements was evaluated for various separations, and conclusions made on the validity of the infinitesimal loop approximation in anisotropic materials. The relative importance of these interactions in polycrystalline graphite is discussed. (auth)

20589 GROWTH-RELATED SURFACE FEATURES ON BeO CRYSTALS REVEALED BY ELECTRON MICROSCOPY. Newkirk, H. W. (Univ. of California, Livermore); Smith, D. K.; Meieran, E. S.; Mattern, D. A. J. Mater. Sci., 2: 194-6(Mar. 1967). (UCRL-70175).

Evidence supporting a layer-growth mechanism in BeO was obtained by studying the topography of the layer sources and the structure of the active sites for BeO molecular attachment (kinks, ledges, or other surface features, which contribute to roughness at layer edges). Electron micrographs yielded little new information regarding the possible existence of growth steps. The most positive and most unusual feature observed was a multi-faceted twin boundary structure. Implications that may be important to growth mechanisms are discussed, including evidence that growth may be controlled by the kinetics of interface attachment. (UK)

20590 RECRYSTALLIZATION, GRAIN GROWTH AND TEXTURES. Papers Presented at a Seminar of the American

Society for Metals, October 16 and 17, 1965. Metals Park, Ohio, American Society for Metals, 1966. 630p.

A collection of thirteen papers presented at the seminar are presented on the study of recrystallization, grain growth, and textures in metals. Subjects covered included: cold work; recovery and recrystallization; recrystallization and crystallization; grain boundaries and grain morphology; and deformation and recrystallization textures. A paper on formation and growth of grains in amorphous metals and one on morphology and textures in polymers are included because of related subject interest. (P.C.S.)

Radiation Effects

Refer also to abstract 20550.

20591 (CONF-660511–, pp 1,7,1-16) TECHNIQUES FOR IRRADIATING HIGH TEMPERATURE MATERIALS IN A STEEP FLUX GRADIENT. Keilhotz, G. W.; Moore, R. E.; Osborne, M. F.; Wieland, B. W.; Zulliger, A. F. (Oak Ridge National Lab., Tenn.).

The J-12 core position of the Engineering Test Reactor is used to irradiate high-temperature materials under a variety of temperature and high neutron flux conditions. Specimen types include ceramic oxides, refractory metal carbides and nitrides, tensile test specimens, and coated fuel particles. A maximum fast neutron dose of 6×10^{21} neutrons/cm^2 can be achieved in one calendar year. The techniques evolved from design and development based on operating experience and the need to accommodate new specimen materials and irradiation condition requirements. Several multiple-capsule assemblies and the facility in which they are operated are described. (auth)

20592 (CONF-660511–, pp 6,1,1-10) COMPARISON OF FUEL BURNUP DETERMINATIONS. Cihi, John J. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center).

Two irradiation programs were selected for comparison of burnup determinations. A total of 22 specimens were available with burnups ranging from 16000 to 114,000 MWd/Mt fuel. One program involved (Pu + U) C fuel samples and the other UO_2 cermets. It was concluded that the calorimetric method of determining burnup during irradiation is workable and shows good agreement with isotopic results to burnups of 40,000 MWd/Mt fuel. (M.C.G.)

20593 (CONF-660511–, pp 3,10,1-4) IN-PILE MEASUREMENT OF THE THERMAL EMF OF UO_2. Pember, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Tests were carried out to determine the thermal EMF produced by a UO_2 fuel core during irradiation. The UO_2 pellets were surrounded by a W grid and the thermal EMF resulted from completion of an electric circuit between these materials at a hot junction near the center of the element and a cold junction near the outside of the element. Measurements of open circuit voltage, short circuit current, and load voltage versus load current were made. (M.C.G.)

20594 (CONF-660511–, pp 3,1,1-6) CAPSULE DESIGN FOR ISOTHERMAL IRRADIATION OF UO_2. Esswein, G. A. (General Electric Co., San Jose, Calif. Nuclear Technology Dept.).

Four capsules were irradiated in the GETR to determine the fission gas release fraction from sintered UO_2 fuel while operating isothermally at nominal temperatures of 1500, 1700, 1900, and 2100°C. A capsule design was evolved for the irradiations, with the objective of minimizing radial and axial temperature gradients within the isothermal sample and maintaining a constant sample temperature over a period of days. Performance data are shown and some preliminary fission-gas release results are given. (M.C.G.)

20595 (CONF-660511–, pp 3,2,1-5) MOLTEN FUEL IRRADIATION TESTS. Pember, L. A.; Panisko, F. E.; Millhollen, M. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A series of irradiation tests was conducted in an attempt to determine the possibility of molten fuel impinging the cladding through cracks formed during reactor shutdown or during operation. To simulate rather gross cracks, capsules containing UO_2 pellets, one pellet of which had a hole drilled along a diameter, were irradiated. (M.C.G.)

20596 SOLID FISSION-PRODUCTS IN IRRADIATED URANIUM DIOXIDE. Bradbury, B. T.; Demant, J. T.; Martin, P. M. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 311-30(Feb. 1967). (AERE-R-5149).

Both solid and gaseous fission-products are generated during the irradiation of UO_2, and the dimensional stability of the fuel is controlled by the behavior of these products. Fragments of irradiated UO_2, and a complete section from a fuel pellet of 4.6% burnup and estimated center temperature of ~1500°C, were studied using an electron probe microanalyzer. A microstructural feature of this type of pellet was the appearance above ~3% burnup of white inclusions at grain boundaries. The solid fission-product elements Mo, Tc, Ru, and Rh were present in all these inclusions. Ba and Sr, associated with Zr, and small amounts of Ce were additionally present in many cases. Nd was present in the matrix UO_2. The chemical state and segregation of these elements are discussed. (auth)

20597 IRRADIATION BEHAVIOUR OF UO_2 PARTICLES IN CERMETS. Lambert, J. D. B. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 331-42(Feb. 1967).

Several miniature UO_2–stainless steel cermet plates were irradiated to 4 to 10% burnup of U atoms at center temperatures of 660 to 750°C. Careful examination of the UO_2 particles after irradiation revealed four features of interest: During irradiation the UO_2 possessed considerable plasticity, which may have enabled it to swell into its residual sintering voidage at the start of irradiation. A swelling rate of approximately 1.7% ΔV per 1% burnup eventually ensued in the UO_2. As burnup progressed, the extent of precipitation of fission-gas bubbles increased, and above about 8% burnup of U atoms a new small grain size appeared in the UO_2. Where temperatures reached ~1000°C a white globular second phase appeared, which probably contained solid fission products. The effect of these features on the overall stability of the cermets during irradiation is briefly discussed. (auth)

20598 KINETICS OF THE ESCAPE OF HELIUM FROM BeO COMPACTS DURING IRRADIATION. Carteret, Y.; Bareau, J.; Elston, J. (Centre d'Etudes Nucleaires, Saclay, Gif-sur-Yvette, France). Proc. Brit. Ceram. Soc., No. 7, 363-74(Feb. 1967).

Neutron irradiation of BeO gives rise to the formation of He (reactions n,2n and n,α). The kinetics of the release of He were studied during irradiation under a flux varying from 1.5×10^{13} to 4.5×10^{13} n$_f$/cm^2 and at temperatures between 1020 and 1350°C. A study of the change of the ratio R/B (where R = the quantity of He escaping in unit time and B = the quantity of He formed) shows that, after a period of induction of about 24 hr, R/B decreases regularly and attains a constant value of between 0.12 and 0.19. These results are interpreted by the capture of atoms by the vacancies created by irradiation. (auth)

20599 DIFFUSIONAL RELEASE OF TRITIUM FROM IRRADIATED BeO. Scott, K. T.; Wassell, L. L. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 375-80(Feb. 1967). (AERE-R-5102).

Measurements of the diffusional release of ^{3}H from BeO on post-irradiation annealing were carried out using a flow/counting technique, with He as carrier gas and a liquid N_2 trap before the counter to remove any condensable species. The material examined consisted of single crystals and powder irradiated at 150°C to doses of 5×10^{19} to 5×10^{20} nvt $\geq$ 1 MeV. Plots of fractional release against $\sqrt{\text{time}}$ yielded straight lines after allowance was made for initial burst effects, and the equivalent sphere model was applied over the temperature ranges employed. From Arrhenius plots of log D $\propto 1/T°K$, activation energies for the diffusion process were derived. These varied from 48 to 59 kcal/mole. The results are compared with those of other authors on similar materials. (auth)

20600 GROWTH OF CERAMIC OXIDES UNDER NEUTRON IRRADIATION. Hickman, B. S.; Walker, D. G. (Australian Atomic Energy Commission Research Establishment, Sydney). Proc. Brit. Ceram. Soc., No. 7, 381-90(Feb. 1967).

Results are given of measurements of macroscopic and lattice growth during neutron irradiation of Al_2O_3 and of BeO, and are compared with previously published data on MgO. In the case of Al_2O_3 and BeO growth equivalence is maintained up to the highest doses measured (5×10^{20} nvt), whereas for MgO equivalence existed only for doses below 10^{20} nvt. The results are discussed in terms of clustering of defects. Although clustering will not affect the growth equivalence, the macroscopic and lattice growths generally differ if loop formation occurs for one component of the damage. In the case of BeO, equivalence persists despite loop formation, implying that defects of high strength exist in the damaged structure. (auth)

20601 THE OBSERVATION OF RADIATION-INDUCED DEFECTS IN BeO BY MEANS OF LONG-WAVELENGTH NEUTRON-SCATTERING MEASUREMENTS. Martin, D. G. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 391-402(Feb. 1967).

The neutron-scattering cross section of defects introduced into BeO by neutron irradiation at 160°C was measured as a function of angle. The cross section is very sensitive to the scattering

angle. Small but significant changes in the cross section occurred on annealing at 650°C for 1 hr; annealing at 1250°C, however, resulted in an almost complete disappearance of the defect scattering. A comparison between these results and the scattering calculated from a number of defect models suggests that, in the as-irradiated state, both very small and rather larger clusters of defects may be present. After annealing at 650°C the smaller clusters disappear and the mean size of the larger defects is roughly 75 point defects per cluster. These larger clusters anneal in the temperature range from 950 to 1250°C. For an irradiation dose of 2×10^{20} neutrons/cm^2 (>1 MeV) the point-defect concentration per molecule after annealing at 650°C is estimated to be 3.6×10^{-2}. (auth)

20602 TRANSMISSION ELECTRON MICROSCOPY OF NEUTRON-IRRADIATED α-Al_2O_3 SINGLE CRYSTALS. Wilks, R. S.; Desport, J. A.; Bradley, R. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceram. Soc., No. 7, 403-22 (Feb. 1967). (AERE-R-5103).

The irradiation-induced macroscopic growth of $\alpha-Al_2O_3$ is anisotropic and depends on the integrated neutron flux and the irradiation temperature. In order to investigate the cause of this growth, $\alpha-Al_2O_3$ single nvt $\geq$ 1 MeV at 150, 650, and 1,000°C, respectively, were examined by transmission electron microscopy. Damage was observed in the form of defect clusters, dislocation loops, dislocation tangles, stacking faults, and cavities. The effect on this damage of post-irradiation annealing at temperatures up to 1800°C was studied. The nature of the damage, before and after post-irradiation annealing, is compared with that observed in neutron-irradiated BeO and MgO. (auth)

20603 EFFECT OF FAST NEUTRON IRRADIATION ON SINTERED ALUMINA AND MAGNESIA. Stevanovic, M.; Elston, J. (Commissariat a l'Energie Atomique, Saclay, Gif-sur-Yvette, France). Proc. Brit. Ceram. Soc., No. 7, 423-38 (Feb. 1967).

Lattice parameters, density, length, stored energy, thermal conductivity, and microstructure were studied in single crystals and sintered samples of Al_2O_3 and MgO irradiated at 60 to 80°C to fast neutron doses of 10^{20} nvt. In sintered Al_2O_3 and MgO x-ray diffraction measurements showed a displacement of lines, produced by lattice parameter expansion. In MgO (but not in Al_2O_3) the lines were also broadened. The elastic modulus and the thermal conductivity decreased. The irradiation damage was greater in MgO than in Al_2O_3 because lattice distortion due to point defects is more important in MgO than in Al_2O_3. In both materials the macroscopic volume expansion was isotropic and approximately equal to the expansion calculated from the lattice-parameter changes. No grain-boundary separation was observed. Thermal annealing showed that recovery takes place between 400 and 1200°C. After annealing, the macroscopic and lattice-parameter growths were no longer identical. In single crystals, irradiation increased microhardness and Young's modulus, and decreased internal friction. (auth)

20604 CHANGES INDUCED IN POLYCRYSTALLINE ALUMINA BY FAST NEUTRON IRRADIATION. Thorne, R. P.; Howard, V. C. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Proc. Brit. Ceram. Soc., No. 7, 439-48 (Feb. 1967). (TRG-Report-1137).

Specimens of between 5 and 30% porosity were irradiated to fast neutron doses up to 16×10^{20} nvt at 250, 475, and 700°C. At the two lower irradiation temperatures specimen length and thermal resistivity increased at a decreasing rate with dose. The increases in length and fractional decreases in thermal conductivity were 0.5% and 5 for a dose of 11×10^{20} nvt at 250°C and 0.4% and 2 for a dose of 16×10^{20} nvt at 475°C. At low doses the macroscopic volume changes and lattice volume changes were identical. At higher doses the macroscopic growth was significantly greater than the lattice growth, and this is believed to be caused by the temperature-dependent diffusion of interstitial defects to form clusters in extra lattice positions. After relatively short irradiations at 700°C 30% porous Al_2O_3 cracked, with an accompanying high bulk growth. Denser sintered specimens increased by 0.15% in length on irradiation at 700°C to a dose of 8×10^{20} nvt, but on further irradiation cracked. The cracking at 700°C is believed to be caused by micro-cracks generated either by irradiation or thermal effects. Marginal changes in Young's modulus were recorded. Within experimental limits the coefficient of thermal expansion was unaffected by irradiation. (auth)

20605 RADIATION-INDUCED CHANGES IN POROUS CUBIC SILICON CARBIDE. Thorne, R. P.; Howard, V. C. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Proc. Brit. Ceram. Soc., No. 7, 449-59 (Feb. 1967). (TRG-Report-1024).

Self-bonded porous β-SiC was irradiated in the Dounreay Materials Testing Reactor to fast neutron doses up to 18×10^{20} nvt at 250, 475, and 700°C. The rate of radioinduced linear growth decreased quickly with increasing dose to give saturation values of 0.73, 0.44, and 0.31% at 250, 475, and 700°C, respectively. X-ray parameter measurements were used to follow the macroscopic growth both during irradiation and subsequent thermal annealing experiments in which the irradiation effects were annealed out at about 1350°C. Saturation occurred for thermal diffusivity as for growth, but the initial rise to saturation tended to be more rapid, and damage did not thermally anneal out at the same temperature. In addition to thermal annealing there was evidence of irradiation annealing. A marginal decrease in Young's modulus was recorded. Within experimental limits the coefficient of thermal expansion was unaffected by irradiation. The radiation damage in porous β-SiC was consistent with a simple model of vacancy and interstitial production. (auth)

20606 IRRADIATION-INDUCED DENSIFICATION OF PYROLYTIC CARBON. Bokros, J. C.; Schwartz, A. S. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Met. Soc. AIME, 239: 7-13 (Jan. 1967).

The irradiation-induced densification of pyrolytic carbon was shown to take place by a simple first-order rate process. The values of the densification constant, k_d, for isotropic carbons are 1.0×10^{-22}, 1.4×10^{-22}, and 2.8×10^{-22} (nvt)$^{-1}$ at irradiation temperatures of 520, 670, and 1000°C, respectively. The apparent activation energy obtained from the temperature dependence of k_d for isotropic C is about 0.2 eV. Estimates of the maximum stresses that develop in isotropic C owing to shrinkage on an unyielding support show that stresses in excess of 15,000 psi may be avoided during irradiation at 600 and 1000°C if the initial coating density is kept above 1.5 and 1.9 g/cm^3, respectively. If a C coating on an unyielding support is not completely isotropic, stresses may continue to build up at high neutron exposures after densification is complete because of continued anisotropic distortion. Stresses in excess of 15,000 psi from this source may be avoided during irradiation at 1000°C if the Bacon anisotropy factor is kept below 1.3. (auth)

Plastics and Other Materials

20607 (GA-7440) PHYSICAL PROPERTIES OF CONCRETE USED IN THE WYLFA (PCRV) DESIGN. Browne, R. D. (Taylor Woodrow Construction Ltd., Southall (England)). Dec. 16, 1966. Contract AT(04-3)-633. 67p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The physical properties examined for concrete used in the Wylfa prestressed concrete pressure vessel included: deformation under sustained load; shrinkage; thermal movements; thermal shock; thermal conductivity; and standard concrete performance properties. The results showed that deformation under load after 3 days from loading increased generally linearly with log time over the temperature range 20 to 93.5°C. Temperature increased the creep rate significantly, particularly with greater age of the concrete. Shrinkage of sealed specimens was large up to 7 days from casting. Expansion of sealed stored specimens heated in a sealed state in the range 20 to 93.5°C was linear with temperature rise. Thermal conductivity data are given for concrete under different conditions. (P.C.H.)

20608 (NASA-CR-54716) SNAP-8 MATERIALS REPORT FOR JANUARY-JUNE 1964. VOL. I. ELECTRICAL INSULATION DEVELOPMENT. Report No. 2880. Dillingham, R. P. (Aerojet-General Corp., Azusa, Calif.). July 1964. Contract NAS5-417. 50p.

Insulation systems that were previously developed were applied to SNAP-8 hardware and the results were studied. The first inorganic-insulated stator was completed, and Aerojet-designed terminal insulators were received. An inorganic-insulated motor has been operated for 8000 hr at 450°F with steadily improving electrical values. Life testing of organic-insulated statorettes was continued at 392°F, with no indication of failure with respect to insulation-resistance values. A new type of monitoring method was devised and checked out for long-term temperature testing of ceramic terminals under vacuum conditions. The compatibility of Cu and mix-4P3E polyphenyl ether was studied, and it was tentatively concluded that the materials are compatible if no oxygen or oxygen source is present. (P.C.H.)

20609 LOW-TEMPERATURE HEAT CAPACITY OF $NdCl_3$ AND $PrCl_3$. Colwell, J. H.; Mangum, B. W. (National Bureau of Standards, Washington, D. C.). J. Appl. Phys., 38: 1468-9 (Mar. 1, 1967).

Heat capacities of $PrCl_3$ and $NdCl_3$ have been measured between 0.3° and 4°K. The dominant feature of the heat-capacity curves is a broad anomaly indicating a region of extensive short-range magnetic ordering. The anomaly in $NdCl_3$ has a maximum at 0.47°K

and fits closely that of a linear Ising chain model. In addition, two small peaks appear at the same temperatures as the sharp spikes found in the magnetic susceptibility. $PrCl_3$ has a sharp peak in the heat capacity at 0.4°K, which is presumably associated with long-range ordering. The broad anomaly in $PrCl_3$ has a maximum at 0.8°K. The magnetic entropy change for the temperature region of the measurements is approximately 80% of R $\log_e 2$ for both salts. (auth)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 20739, 20740, 20797, and 20855.

20610 (N-67-16094) A COSMOLOGICAL MODEL FOR OUR UNIVERSE. I. Chiu, Hong-yee (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies). [1966]. 87p. (NASA-TM-X-59317). CFSTI $3.00 cy, $0.65 mn.

A cosmological model was constructed for the Universe, based on current astronomical observations and two basic assumptions: Einstein's theory of general relativity is strictly valid without the cosmological constant and the existing laws of physics are strictly valid. Present knowledge of astronomical observations of the Universe and the cosmological models acceptable under the above assumptions are reviewed. Using statistical physics for equilibrium and nonequilibrium processes the course of evolution of the Universe was reconstructed, and an upper limit for the allowable matter-density of the Universe was obtained. It was found that the bulk part of matter-density is in galaxies. The evolution of antimatter was calculated, and it was found that antimatter must be totally absent. Based on the results obtained, a value of 0.02 for the deceleration parameter q_0 was determined. It was concluded that the Universe can be described by an open cosmological model of the Friedman type. (auth)

20611 ON THE NATURE OF THE SOURCE OF X-RAY EMISSION OF SCO XR-1. Shklovskii, I. S. (Moscow State Univ.). Astrophys. J., 148: L1-4(Apr. 1967).

Recently the brightest source of x-ray emission Sco XR-1 was identified with an optical object of 13 mag. The object is reminiscent of an old nova. At present it is felt that the mechanism of the x-ray emission of the source may be explained by the bremsstrahlung of an optically thin layer of very hot plasma. According to this interpretation the main part of the optical emission is a low-frequency continuation of the bremsstrahlung. However, the latter conclusion in the opinion of the author does not seem to be right in view of two considerations which are discussed in some detail. A "three-layer" model of Sco XR-1 is described which corresponds to a neutron star in a state of accretion. (W.D.M.)

20612 THE SIZE AND POSITION OF THE X-RAY SOURCE IN THE CRAB NEBULA. Oda, M. (Massachusetts Inst. of Tech., Cambridge); Bradt, H.; Garmire, G.; Spada, G.; Sreekantan, B. V.; Gursky, H.; Giacconi, R.; Gorenstein, P.; Waters, J. R. Astrophys. J., 148: L5-11(Apr. 1967). (MIT-2098-296).

During a recent rocket flight, the 1- to 6-keV x rays from the Crab Nebula were observed with a modulation collimator of high resolution. It was found that the emission region is centered on the Crab and is of finite size. The results are in agreement with those of the lunar occultation experiment. The present measurement provides size and position information along two nearly perpendicular directions rather than the one direction of the lunar transit. Since the measurements of Sco XR-1 and the Crab Nebula were made with the same instrument during a single flight, the qualitatively different appearance in x rays of a starlike source and a source of finite angular size (Crab) was directly observed. (W.D.M.)

20613 THE TWO ABSORPTION-LINE REDSHIFTS IN PARKES 0237-23. Greenstein, Jesse L.; Schmidt, Maarten (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 148: L13-15(Apr. 1967).

This radio source, which has a curved rf spectrum, was identified by Arp, Bolton, and Kinman (1967) with a bluish stellar object of 16.6 mag. Two good spectra were taken with a Baush and Lomb grating, 1200 lines/mm, which gave 89 Å/mm in the first order with the Palomar prime-focus spectrograph. The spectra were widened to 0.1 mm on specially baked plates developed to provide the highest speed, with some small loss of resolution. About 150 possible absorption features were measured, from which a carefully selected list of 100 lines from the one plate was used for a preliminary analysis. The lines were sharp and deep, resembling those in a cool or shell star. The resolution was between 1 and 2 A. It was found that two velocity systems are in fact present, with red shifts of $z_1 = 2.2020$, and $z_2 = 1.9555$. (W.D.M.)

20614 HIGH-RESOLUTION RADO OBSERVATIONS OF AN INTENSE H II REGIONS IN CYGNUS X. Ryle, M. (Cambridge Univ., Eng.); Downes, D. Astrophys. J., 148: L17-21(Apr. 1967).

Observations of an intense microwave source in Cygnus X were made with the Cambridge 1-mile radio telescope at 0.408 and 1.407 Gc. The source consists of a bright component of angular diameter 20", a weaker component of approximately the same size, and a third component extending some 3 to 4'. The main component has a thermal spectrum, with an electron temperature of 11,000°K. Its emission measure is 5×10^7 cm^{-6} pC, the highest yet derived for a galactic radio source. (auth)

20615 RADIO EMISSION FROM STELLAR CORONAS. Seaquist, E. R. (Univ. of Toronto). Astrophys. J., 148: L23(Apr. 1967).

The 150-ft paraboloid of the Algonquin Radio Observatory was used in a program to search for radio emission at a wavelength of 2.85 cm from stars which show spectroscopic evidence of mass loss. The results from four stars observed to date are presented. They include three red giants α Ori, π Aur, ψ Aur, and one O-type star δ Ori. The total observing time for each star was approximately 90 min. It was conduced from the observations that radio emission may have been detected from the stars α Ori and π Aur. (W.D.M.)

20616 DETECTION OF THE HYDROGEN EMISSION LINE 253 α. Penfield, H.; Palmer, Patrick; Zuckerman, B. (Harvard Univ., Cambridge, Mass.). Astrophys. J., 148: L25-8(Apr.. 1967).

Previously the detection of hydrogen recombination lines 156α, 158α, and 166α in galactic H(II) regions were reported. These lines occur at 1715.673, 1651.541, and 1424.734 MHz, respectively. The detection of the 253α line at 403.681 MHz in the galactic radio source W80, which is identified with the North American nebula, NGC 7000, is reported. The line was detected with the 140-ft telescope of the NRAO in Green Bank, West Virginia. (W.D.M.)

20617 ADDITIONAL OBSERVATIONS OF INFRARED STARS. Wisniewski, W. Z.; Wing, R. F.; Spinrad, H.; Johnson, H. L. (Univ. of Arizona, Tucson. Univ. of California, Berkeley). Astrophys. J., 148: L29-32(Apr. 1967).

Multicolor photometric observations were made of all but one of the infrared stars in the second list published by the observers at California Inst. of Tech. and spectroscopic observations of eight. The new observational data are tabulated. The photometric system is that of Johnson, et al. (1966); the M-star types are based upon the strengths of the TiO and UO bands in the near-infrared, while the carbon star classifications depend upon the recognition of strong near-infrared CN bands. (W.D.M.)

20618 SOLAR MODULATION AND THE ENERGY DENSITY OF GALACTIC COSMIC RAYS. Gloeckler, G.; Jokipii, J. R. (Univ. of Chicago). Astrophys. J., 148: L41-6(Apr. 1967).

Present knowledge permits the residual solar modulation of cosmic rays in 1965 to be expressed in terms of only one undetermined constant which expresses the magnitude of modulation. A firm upper bound is placed on this parameter by considering the local interstellar cosmic-ray energy density. (auth)

20619 ON THE POLARIZATION OF SCO X-1. Hiltner, W. A.; Mook, Delo E.; Ludden, D. J.; Graham, D. (Yerkes Observatory, Williams Bay, Wis.). Astrophys. J., 148: L47-8(Apr. 1967).

Sco X-1 was observed with the 36-inch reflector of the Cerro Tololo Inter-American Observatory in Chile on four consecutive nights, Feb. 16 through 19, 1967 U.T. The object was near minimum on two nights and near maximum on the other two. Individual observations suggest a small polarization, and this is reflected in the mean that gives a polarization of approximately 0.015 mag. at a position angle of about 115°. (W.D.M.)

20620 SYNTHESIS OF ELEMENTS AT VERY HIGH TEMPERATURES. Wagoner, Robert V.; Fowler, William A.; Hoyle, F. (California Inst. of Tech., Pasadena. Cambridge Univ., Eng.). Astrophys. J., 148: 3-49(Apr. 1967).

A detailed calculation of element production in the early stages of a homogeneous and isotropic expanding universe as well as within imploding-exploding supermassive stars was made. If the recently measured microwave background radiation is due to primeval photons, then significant quantities of only D, ^{3}He, ^{4}He, and ^{7}Li can be produced in the universal fireball. Reasonable agreement with solar-system abundances for these nuclei is obtained if the present temperature is 3°K and if the present density is $\sim 2 \times 10^{-31}$ gm cm^3, corresponding to a deceleration parameter $q_0 \approx 5 \times 10^{-3}$. However, massive stars "bouncing" at temperatures $\sim 10^9$°K can convert the universal D and ^{3}He into C, N, O, Ne, Mg, and some heavier elements in amounts observed in the oldest stars. The mass gaps at A = 5 and 8 are bridged by the reactions ^{3}He(^{4}He,γ)^{7}Be(^{4}He,γ)^{11}C. Bounces at higher temperatures bridge the mass gaps through 3 ^{4}He $\rightarrow$ ^{12}C and mainly produce metals of

the iron group, plus a small amount of heavier elements synthesized by a new kind of r-process (rapid neutron capture). It is found that very low abundances of ^{4}He, as recently observed in some stars, can be produced in a universe in which the electron neutrinos are degenerate. (auth)

20621 PRIMORDIAL ELEMENT FORMATION, PRIMORDIAL MAGNETIC FIELDS, AND THE ISOTROPY OF THE UNIVERSE. Thorne, Kip S. (Princeton Univ., N. J. California Inst. of Tech., Pasadena). Astrophys. J., 148: 51-68(Apr. 1967).

A detailed discussion is presented of homogeneous cosmological models which (i) have two equivalent "tangential" directions and one inequivalent "longitudinal" direction at each point in spacetime; (ii) have zero rotation; (iii) contain a perfect fluid obeying an equation of state $p = p(\rho)$; and (iv) contain a magnetic field frozen into the matter and pointing in the longitudinal direction. By means of these cosmological models it is shown that, if the big-bang general-relativistic theory of the universe is correct, and if the galactic magnetic fields which are observed today were primordial in origin, then the universe was probably very anisotropic in its early stages. These cosmological models are also used to evaluate the implications of astronomical observations for the isotropy of the universe. It is shown that the current 3% limit on the anisotropy of the cosmic microwave radiation places limits on the large-scale isotropy of the universe, which are many orders of magnitude stronger than limits inferred from the observed isotropy of extragalactic redshifts. Finally, an analysis is presented of primordial element formation in anisotropic cosmological models. One of the chief conclusions is this: if there has been a negligible amount of intergalactic H II ever since the primordial photons were sufficiently energetic to ionize hydrogen, and if the universe is Euclidean but anisotropic in its large-scale geometry, then the current limit of 3% on the microwave anisotropy requires $\gtrsim$8% primordial ^{4}He by mass and (unless ^{4}He is $\gtrsim$27%) $\gtrsim$ 20% primordial D and $\gtrsim$0.5% ^{3}He. More stringent limits on microwave anisotropy will push the limit on primordial ^{4}He somewhat higher. (auth)

20622 TERMINATION OF THE s PROCESS. Clayton, Donald D.; Rassbach, M. E. (Rice Univ., Houston, Tex.). Astrophys. J., 148: 69-85(Apr. 1967).

The nucleosynthesis of heavy stable nuclei by successive captures of neutrons in a weak neutron flux (the s process) is terminated at large atomic weight by alpha decay to isotopes of lead. The details of this termination are analyzed and the abundances of lead and bismuth isotopes synthesized by the exposure of lighter nuclei to neutrons are calculated. It is demonstrated that the results are nearly insensitive to the poorly known neutron-capture cross section of ^{208}Pb. The continuous distribution of integrated neutron exposures responsible for the observed abundances has an anomalously large high-exposure component. This result suggests that the bulk of the lead has been synthesized by special astrophysical circunstances rather than by a smooth extension of the circumstances attending the synthesis for A < 200. (auth)

20623 21-CM LINE OBSERVATIONS OF GALACTIC H(II) REGIONS. Riegel, Kurt W. (Univ. of Maryland, College Park). Astrophys. J., 148: 87-103(Apr. 1967).

Twenty-seven galactic H(II) regions have been observed in the 21-cm spectral line using the 300-foot transit radio telescope and the 100-channel digital autocorrelator of the National Radio Astronomy Observatory. Neutral hydrogen components associated with IC 5146, NGC 281, S170, and S222 have been detected. IC 5146 has an H(I) mass of 670 M$\odot$ and an H(II) mass of 20 M$\odot$, and is not a simple isolated gravitationally bound system. NGC 281 has an H(I) mass of at least 16,000 M$\odot$, and an H(II) mass of 880 M$\odot$. In both cases the 21-cm systemic velocity is in agreement with the optical value. IC 5146 and NGC 281 both contain star clusters, and all four objects with H(I) associated with them have patches of obscuration crossing them. There is no direct observational evidence for the existence of an expanding H(I) component containing an appreciable fraction of the observed neutral hydrogen mass in any of the cases reported. Seven high-latitude H(II) regions have no neutral hydrogen associated to an upper limit of 8°K brightness temperature. The sixteen remaining H(II) regions either had no clear H(I) features visible above the large-scale background or were located in regions so complex as to make detection impossible. (auth)

20624 NEUTRAL OXYGEN IN LATE-TYPE STARS. Conti, Peter S. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Greenstein, Jesse L.; Spinrad, Hyron; Wallerstein, George; Vardya, M. S. Astrophys. J., 148: 105-27 (Apr. 1967).

The forbidden absorption nebular and auroral lines of oxygen in the spectra of about seventy G and K stars, mostly giants, were identified. While weak, they appear in a relatively uncrowded spectral region and can be studied at high dispersion. Coming from the ground state of a dominantly neutral element, the nebular lines are insensitive to differences of model and non-equilibrium effects in line formation. They are formed over a wide range of optical depth and are therefore insensitive to the detailed structure near the boundary temperature. Approximate model atmospheres predict the expected changes in the [O I] line strength as compared with its strength in the sun; the models use a $T(\tau)$ relation scaled from that in the sun and opacity tables. The depletion of the free atomic oxygen is caused mostly by CO formation which must be included in detail. Equivalent widths of forbidden oxygen lines in about one-third of the stars were measured and they were estimated in the other two-thirds. The measured strengths, from 12 to 140 mÅ, together with theoretical calculations, lead to the following conclusions: 1. Most stars have a solar abundance ratio of O/C, near 1.6, and the solar absolute abundances of both these elements. 2. The forbidden lines are observed to be strengthened in the stars with weak CN and high velocity, such as α Boo. These stars are mildly metal deficient (by a factor of 2–4), but have a larger O/metals ratio than does the sun. The O/C ratio and O/H ratios are probably the same as in the sun. The observed weakness of CN may be caused primarily by a low N/H ratio. 3. Stars with strong CN such as α Ser have weak [O I], an O/C ratio of about 1.2, probably caused by a slight carbon abundance enhancement. The increased CN line strength in these stars is caused primarily by enriched nitrogen. It is suggested that this originates during helium flash and mixing. 4. Moderately metal-deficient stars, such as HD 148897, have a large O/metals ratio. It could be that this quite weak-lined star has an oxygen abundance as high as the sun. 5. The oxygen lines are not observed in the high-velocity, extremely metal-deficient star HD 122563. Oxygen is deficient, but perhaps not as much so as the metals. During the early phases of nucleosynthesis in our galaxy, the oxygen content increased at a different rate than the metals and reached its present abundance much more rapidly. This may also be true for carbon, but studies of the CN and CH bands and detailed molecular equilibria will be required. Helium burning in massive red giants, or in supermassive stars, apparently proceeded more rapidly than iron-peak element synthesis. Evolution within a star that would lead to increases of surface O and C abundances is not probable except in highly evolved stars. (auth)

20625 STUDIES OF STELLAR ROTATION. IV. A COMPARISON OF ROTATIONAL VELOCITIES IN THE ALPHA PERSEI CLUSTER AND THE PLEIADES. Kraft, Robert P. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 148: 129-39(Apr. 1967).

The rotational velocities of nearly all stars in the α Per cluster brighter than $M_v = +3.5$ were determined. The function $\langle V \sin i \rangle$ is shown to be larger than that for the field stars. It agrees well with $\langle V \sin i \rangle$ for the Pleiades, thereby supporting Eggen's suggestion that the two clusters have a common origin. The frequency distribution f of rotational velocities is derived and is found to be fairly well represented by a Maxwellian distribution. The difference between f in α Per and the Pleiades and f in the field for stars in the range $-0.05 < B - V < +0.10$ is briefly discussed. (auth)

20626 CIRCUMSTELLAR ENVELOPES FORMED THROUGH ROTATIONALLY FORCED EJECTION. II. Limber, D. Nelson (Univ. of Chicago). Astrophys. J., 148: 141-57(Apr. 1967).

The structure of circumstellar envelopes formed as a result of the continuing rotationally forced ejection of matter by stars is considered. The dynamics of such envelopes near their equatorial planes is treated in a general way for the case of steady-state solutions with arbitrary distributions of temperature and circular component of velocity, and the particular case of steady-state solutions for isothermal envelopes with negligible viscosity is treated in detail. Included are brief discussions of the energy and viscosity problems, the relation of the problem of continuing rotationally forced ejection to that of the solar wind, the nature of possible applications and tests of the hypothesis of continuing rotationally forced ejection, and the possibility of non-steady-state solutions and their implications for stellar evolution. (auth)

20627 TRIAXIAL FIGURES OF EQUILIBRIUM FOR CENTRALLY CONDENSED MASSES. Clement, Maurice J. (Princeton Univ., N. J.). Astrophys. J., 148: 159-74(Apr. 1967).

Equilibrium models with triplanar symmetry but without any axisymmetry were constructed for centrally condensed masses in a state of nonuniform rotation. The triaxial property of the configurations derives from the introduction of an irrotational velocity field. The sequence of models presented ranges from a sphere to a figure for which the ratio of the longest and the shortest axes (both of which lie in the equatorial plane) is about 2 : 1. (auth)

20628 EFFECT OF INTERSTELLAR MATERIAL ON STELLAR NONCIRCULAR VELOCITIES IN DISK GALAXIES. Julian,

William H. (Univ. of Chicago). Astrophys. J., 148: 175-84 (Apr. 1967).

The question of the secular increase of stellar noncircular velocities in the disk portions of the galaxy and similar systems is reexamined. The possible gravitational disturbances from interstellar gas inhomogeneities on spiral structure scales are discussed with the inclusion of forces from accompanying standing waves of star density. Attention is restricted to the disk portion of a galaxy, where a "local" and "thin disk" model is used. Based on this model, the process is shown to derive the required energy from the differential rotation and gravitation of the star disk. It is estimated numerically to produce important increases in the mean stellar velocity dispersions during galactic lifetimes under reasonable assumptions regarding the amount and distribution of the interstellar material. (auth)

20629 SUPPRESSION OF THE JEANS INSTABILITY IN COLLISIONLESS MEDIA. Lee, Edward P. (Univ. of Chicago). Astrophys. J., 148: 185-91(Apr. 1967).

The behavior of plane-wave disturbances in an infinite rotating collisionless system is examined in the special case in which the wave vector is normal to the axis of rotation. It is shown that the system is stable with respect to such disturbances provided the rate of rotation exceeds a certain critical value. This result coincides with that known for a collision-dominated gas. (auth)

20630 STABILITY OF A SELF-GRAVITATING HYDROMAGNETIC CYLINDER. Graham, R. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 148: 193-205(Apr. 1967).

The method of virtual work is used to study systems with a general axially symmetric magnetic field. Stabilities of all symmetries are examined. The behavior in the limits of long and short wavelength is discussed. The axisymmetric and "wriggle" instabilities of long wavelength are readily found; but it is shown that perturbations of higher helical symmetry are stable, provided that the azimuthal field divided by the radius has a fine lower bound. Also, for most fields, perturbations of short wavelength are stable. It is shown that the critical wavelength for axisymmetric perturbations in the absence of a field remains unaltered by a field which vanishes on the surface and is not twisted beyond a certain limit. The applicability of the conclusions to spiral arms is discussed. (auth)

20631 RADIATIVE TRANSFER. I. THE FLUX-TEMPERATURE RELATION AND NON-GRAY STELLAR ATMOSPHERES. Henyey, Louis (Univ. of California, Berkeley). Astrophys. J., 148: 207-16(Apr. 1967).

The problem of non-gray model atmospheres is reviewed. An improved iterative procedure is considered which is based on the rigorous solution of Milne's second integral equation for the Planck function in terms of the flux. Applying the solution at each wavelength with allowance for both absorption and scattering, and using the assumption that F_μ/F does not vary between iterations to any great extent, a temperature correction method is proposed. The approximate evaluation of certain new functions is considered. (auth)

20632 ANGULAR MOMENTUM OF THE SOLAR WIND. Weber, Edmund J.; Davis, Leverett Jr. (California Inst. of Tech., Pasadena). Astrophys. J., 148: 217-27(Apr. 1967).

A steady-state model of the solar-wind flow in the equatorial plane including the effects of pressure gradients, gravitation, and magnetic forces is developed and solved for both the radial and azimuthal motions. The viscosity is taken to be zero, the electrical conductivity to be infinite, and the energy supply characterized by a polytropic index. The solution must pass through three critical points, whose significance is explained in terms of the characteristic velocities with which disturbances propagate. A numerical solution is obtained for typical parameters. The magnetic field produces only a modest tendency toward co-rotation of the outer corona, but the magnetic stresses apply a torque to the sun equal to that required to produce effective co-rotation out to the radial distance where the radial Alfvénic Mach number equals unity. For typical solar-wind values this will occur between 15 and 50 solar radii out, which implies a substantial loss in the angular momentum of the sun. (auth)

20633 EXCITATION OF THE INFRARED LINES OF Fe(XIII) IN THE SOLAR CORONA. Malville, J. McKim (High Altitude Observatory, Boulder, Colo). Astrophys. J., 148: 229-38(Apr. 1967).

The intensity ratios of λ10747 and λ10798 are calculated for an eighteen-level model ion having the $3s^23p^2$, $3s3p^3$, $3s^23p3d$ states. The collision strength, $\Omega(^3P_0, ^3P_1)$ is close to 0.03 as indicated by a comparison with observed ratios. The abundance of iron relative to hydrogen appears to be approximately 6×10^{-5} in the corona as determined from observed line to continuum ratios of λ10747. The per cent linear polarization of the infrared lines in a coronal streamer is estimated taking collisional excitation into account. (auth)

20634 OSCILLATOR STRENGTHS FOR RESONANCE LINES OF IONS IN THE NEON ISOELECTRONIC SEQUENCE. Kastner, S. O.; Omidvar, K.; Underwood, J. H. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 148: 269-73(Apr. 1967).

Oscillator strengths are calculated for some extreme ultraviolet resonance lines of ions in the neon isoelectronic sequence, on the basis of single configurations in intermediate coupling. Making plausible assumptions concerning the conditions of excitation in the corona and in spark sources, fairly good agreement is found with observation in the case of the important coronal Fe(XVII) lines, but the results of the calculations disagree with the few observations of earlier ions in the sequence. If the comparison is meaningful, configuration interaction may be responsible. (auth)

20635 THE RADIO SOURCE 3C 17. Moffet, A. T. (California Inst. of Tech., Pasadena); Schmidt, M.; Slater, C. H.; Thompson, A. R. Astrophys. J., 148: 283-6(Apr. 1967).

Recently 3C 17 has been occulted several times by the moon. Observations of these events have resulted in a good position for the source. There is a galaxy near this position, and its identification with the radio source is confirmed by the presence of emission lines in its optical spectrum. Observational data on 3C 17 are summarized. (W.W.M.)

20636 STABILIZATION OF CLUSTERS OF GALAXIES BY IONIZED GAS. Woolf, N. J. (Goddard Inst. for Space Studies, New York. Columbia Univ., New York). Astrophys. J., 148: 287-90(Apr. 1967).

Ionized matter may be seen by the line spectrum produced during recombination or by the continuum of free–free transitions of the electrons. The initial results of new observations to search for recombination radiation are described, and previous observations relevant to the detection of free–free emission are discussed. (W.D.M.)

20637 MAGNETOSPHERES OF SELF-GRAVITATING BODIES. Woltjer, L. (Columbia Univ., New York). Astrophys. J., 148: 291-3(Apr. 1967).

In theories of radio sources and cosmic-ray acceleration, frequently a situation is envisioned in which a gas or relativistic particles are confined by a magnetic field which is anchored in a central body that is kept in equilibrium by its self-gravitation. Some general theorems applicable to this situation are derived. (W.D.M.)

20638 INFRARED CONTINUUM FROM H II REGIONS. Stein, Wayne A. (Univ. of California, San Diego, La Jolla). Astrophys. J., 148: 295-7(Apr. 1967).

Recent observations of the planetary nebula IC 418 have indicated a measurable flux of about 10^{-16} watt cm^{-2} near a wavelength of 13 μ. This observation has been interpreted as emission from Ne^+ at 12.8 μ. In order to investigate alternative explanations, the expected flux of infrared free–free emission from planetary nebulae was calculated. The results show that the free–free flux, although not large enough to explain the observed flux from a nebula such as IC 418 near 13 μ, should be detectable from some planetaries at the shorter infrared wavelengths of 3 to 5 μ. (W.D.M.)

20639 COULOMB DE-EXCITATION OF ^{12}C IN A HELIUM GAS AT HIGH DENSITY AND TEMPERATURE. Clayton, D. D.; Shaw, P. B. (Rice Univ., Houston, Tex.). Astrophys. J., 148: 301-3(Apr. 1967).

The radiative de-excitation of an excited residual nucleus is a familiar mechanism for the completion of nuclear reactions in both the laboratory and the stellar interior. In particular, the rate for the helium-burning reaction, $He^4 + Be^8 \rightarrow C^{12*}(2+) + \gamma$, is proportional to the electric quadrupole radiative width for the transition from the 7.65-MeV 0+ state to the 4.43-MeV 2+ state of C^{12}. The electromagnetic de-excitation of $C^{12*}(0+)$ by scattering with a helium gas is considered. The relative importance of helium-induced electromagnetic transitions and radiative transitions in C^{12} is examined for a range of density (10^9 to 10^{12} gm/cm^3) and temperature (10^9 to 10^{10} °K) found in supernovae. (W.D.M.)

20640 LINEAR STAR MODEL AND DYNAMICAL INSTABILITY. Stothers, Richard; Frogel, Jay A. (Goddard Inst. for Space Studies, New York. Harvard Univ., Cambridge, Mass.). Astrophys. J., 148: 305-9(Apr. 1967).

The linear model of a star represents one class of models for which the equations of stellar structure may be integrated in closed form. In this model the density distribution is specified a priori and is given by the linear relation $\rho = \rho_c (1 - x)$, where $x \equiv r/R$ is the radius fraction of the star and ρ_c is the central

density. Recently, the linear model has been used in an extensive exploration of the basic features of stellar structure and evolution. The pulsational properties of stellar models with a linear density distribution given by the above equation are derived. First, the radial, adiabatic modes of pulsation of the linear model and, second, the general dynamical stability of a star against radial perturbations are considered, with a particular application to the linear model. (W.D.M.)

20641 PRECISION ABSOLUTE MEASUREMENTS OF RADIATION FLUXES OF DISCRETE SOURCES OF TAURUS-A AND CASSIOPEIA-A AND RADIO WAVE ABSORPTION IN ATMOSPHERE AT THE WAVE LENGTH OF $\lambda = 5.28$ cm. Dmitrenko, D. A.; Strezhneva, K. M. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 165-9(1967). (In Russian).

The results are given of absolute measurements of radiation fluxes of the discrete sources of Taurus-A and Cassiopeia-A at $\lambda = 5.28$ cm, made by using the precision measurement method, based upon the comparison of the received radio emission with thermal radio emission of an "absolute black" disk, being placed in antenna Fraunhofer zone. The fluxes were $(6.46 \pm 0.3) \cdot 10^{-24}$ $vt \cdot m^{-2}$ cps for Taurus-A and $(7.7 \pm 0.4) \cdot 10^{-24}$ $vt \cdot m^{-2}$ cps for Cassiopeia-A. The measurement results of the radio wave absorption in the atmosphere are given. The absorption value in oxygen was equal to $\Gamma_0 = 6 \cdot 10^2$ (db); the absorption factor in water vapor was equal to $\alpha = 4 \cdot 10^{-4}$ $(db \cdot km^{-1} \cdot m^3 \cdot g^{-1})$. The accuracy of the given results is 15%. (auth)

20642 DIFFUSION OF PLASMA IN SUPERMASSIVE STARS. Nedyalkov, I. P. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 1135-8(1966).

Plasma is known to be very rare in supermassive stars; it is "dissolved" in photon gas. The question arises, therefore, whether plasma diffusion will not be so intensive as to affect greatly the structure of these stars. The results of a study is presented which suggest that this is not the case. (W.D.M.)

20643 STELLAR WINDS. Stepien, Kazimierz. Postepy Astron., 15: 3-14(1967). (In Polish).

A discussion is presented on the physical conditions in the solar corona leading to the permanent outflow of the coronal matter (solar wind). Rough estimates of the same process in other stars are also outlined. The results show that the existence of stellar wind influence the evolution of red giants but more precise data cannot be obtained without a more accurate knowledge on the flux of the mechanical energy going from the convective zone to the stellar corona. (auth)

20644 EMPIRICAL MODEL OF THE SOLAR ATMOSPHERE WITH LOCAL THERMODYNAMIC EQUILIBRIUM. Holweger, Hartmut. Z. Astrophys., 65: 365-417(1967). (In German).

Assuming LTE consistently, an empirical model of the solar photosphere and lower chromosphere is constructed which is able to reproduce continuous and line spectrum both at the center of the solar disk and at the limb. To determine this model, profiles of 900 carefully selected lines (Michigan photoelectric atlas) of 31 atoms and ions were used together with the continuum intensity and their center-to-limb variation. No values were needed. In the lower chromosphere ($\bar{\tau} \sim 10^{-6}$) the temperature decreases to 3900°K. The microturbulence turns out to be anisotropic and decreases with height in the range $\bar{\tau} \sim 1$ to 10^{-3} from 2.5 resp. 3 km/sec (vertical resp. horizontal component) to ~1 km/sec (both components). For interpretation of line profiles, the assumption of LTE is entirely sufficient up to the lower chromosphere ($\bar{\tau} \sim 10^{-6}$), with exception of resonance lines: their observed central depths exceed the computed ones. Small deviations also seem to exist among stronger lines observed near the limb, but the excitation temperature is only ~50°K lower than the kinetic temperature. These deviations are insignificant for abundance determinations. (auth)

20645 QUANTITATIVE ANALYSIS OF THE SPECTRUM OF THE F8V-STAR BETA VIRGINIS. Baschek, B.; Holweger, H.; Namba, O.; Traving, G. Z. Astrophys., 65: 418-55(1967). (In German).

A differential fine analysis of the F8V star β Vir relative to the sun was carried out using high dispersion spectra and model atmosphere techniques. An effective temperature $T_e = 6120° \pm 100°$, a surface gravity $\log g = 4.29 \pm 0.1$ (assuming the solar helium abundance), and a microturbulent velocity $\xi = 3$ km/sec were derived. The metals were found to have a mean overabundance with respect to the sun by a factor of $2 : [\epsilon_M/\epsilon_H] = +0.3 \pm 0.2$. All observable metals (C, Na through La) showed the same relative abundance distribution as in the sun. The negative ultraviolet excess $\delta(U-B)$ of β Vir vanishes when taking account of the correction for the lower gravity, thus locating the star on the Hyades sequence. The age of β Vir is comparable to that of M 67. (auth)

20646 MODIFICATION OF WEIGHTING FUNCTION METHOD FOR CALCULATING THE FRAUNHOFER LINES IN SOLAR AND STELLAR SPECTRA. Gussmann, E. A. (Deutsche Akademie der Wissenschaften, Berlin). Z. Astrophys., 65: 456-97(1967). (In German).

A modification of the weighting function method is proposed introducing the derivatives of the hitherto used functions. This method allows the accurate computation of stellar spectra (flux) by means of weighting functions. Moreover, line profiles and equivalent widths both in solar (intensity) and stellar (flux) spectra can be uniformly described. The computation of Fraunhofer lines is reduced to the calculation of weighting functions and functions of growth, i.e., profiles or equivalent widths in an absorption tube. Analytical formulas and numerical values of these functions are given in the case of a constant-damping parameter. An approximate relation between the exact formulas and the schematic curves of growth applied in coarse analysis of stellar spectra is found. The well-known method of contribution curves is revised using the new weighting functions. The integro-exponential functions are generalized. Representations by integrals, Taylor series, asymptotic formulas, recurrence formulas, and other useful relations are collected. A special set of functions are tabulated. (auth)

20647 EVOLUTION OF THE RADIO SPECTRAL INDEX OF SUPERNOVA REMNANTS. Sofia, Sabatino; O'Connell, R. F. (Goddard Space Flight Center, New York). Z. Astrophys., 65: 498-500(1967).

On the basis of observational evidence, Harris, 1962, proposed that the radio spectra of supernova remnants undergo an evolutionary flattening with time. The diameter 2R of each remnant was plotted against its spectral index, and it was shown that the resultant curve could be fitted by a relation of the form $\gamma = 2\alpha + 1 = aR^{-b}$, where α is the spectral index, and a and b are constants equal to 3.2 and 0.36, respectively. The physical process or processes that are responsible for the decrease of γ with time are considered. (W.D.M.)

20648 ON THE DIFFERENTIAL DISPLACEMENT OF FRAUNHOFER LINES IN THE SPECTRA OF THE SUN. Salman-Zade, R. Kh. Vestn. Leningr. Univ., No. 19, Ser. Mat., Mekh. Astron., No. 4, 129-32(1966). (In Russian).

Differential residual displacements of more than 600 Fraunhofer lines were measured for the west point of the equator on the limb. The method of measurement used enables one to have the displacement without any standard lines of known wave length (laboratory or atmospheric). The meaning of the displacements is obtained, and the dispersion around these values is about 0.0040 Å. The errors (r.m.s.) obtained from the measurement of atmospheric lines are about 0.0008 Å. (auth)

20649 PRODUCTION OF PROTON-RICH HEAVY SHIELDED ELEMENTS FROM S-ELEMENTS IN SYSTEMS AT HIGH TEMPERATURE. Scotto, M.; Paoli, G.; Wataghin, A. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cimento (10), 48B: 119-26(Mar. 11, 1967).

The possibility of explaining the observed abundance (or part of it) of ^{164}Er by examining the isobar chain $^{164}Dy \rightarrow {}^{164}Ho \rightarrow {}^{164}Er$ has been studied. The β processes that may transform ^{164}Dy into ^{164}Ho and ^{164}Er and those which may bring ^{164}Er back to ^{164}Ho and ^{164}Dy must be taken into account. The mechanism analyzed is found to be efficient for the production of ^{164}Er. Its application to other proton-rich heavy shielded elements is in principle possible. (auth)

20650 MEASUREMENT OF SOLAR PROTONS WITH ENERGIES OF 1 TO 5 MeV BY THE VENERA-2, VENERA-3, AND ZOND-3 SPACE PROBES. Vernov, S. N.; Chudakov, A. E.; Vakulov, P. V.; Logachev, Yu. I.; Lyubimov, G. P.; Nikolaev, A. G.; Pereslegina, N. V. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 171: 847-50(Dec. 1, 1966). (In Russian).

During the flights of the Zond-3, Verena-2, and Venera-3 space probes, the counting rate of proton detectors and Geiger counters on board increased markedly on six occasions. The semiconductor surface-barrier proton detectors had an area of about 0.2 cm^2; the p–n junction was 35-μ thick. On the side of free space within a solid angle of ~1 sterad, the detectors were shielded with 2 mg/cm^2-thick aluminum foil; on other sides the shielding was more than 1 g/cm^2 thick. The detectors were tuned to record protons with energies varying from 1 to 5 MeV. The intensity range measured corresponded to 1.1×10^{-3} to 1.1 pulse/sec. An analysis of the recorded data indicates that the protons are accelerated on the sun and are propagated without hindrance along the magnetic force lines in interplanetary space. The width of proton fluxes with energies of 1 to 5 MeV was estimated at 3×10^{12} cm. It is concluded that these protons of comparatively low energies are generated periodically from the active areas on the sun. They reach distant

regions in interplanetary space through a "tunnel" produced by the corpuscular streams. (ATD)

20651 ANTIMATTER AND COSMOLOGY. Alfven, Hannes. Sci. Amer., 216: No. 4, 106-12; 114(Apr. 1967).

A cosmological theory that takes into account the basic symmetry between particles and antiparticles is discussed. The theory suggested by Klein started with two basic premises: that the universe at large is composed of equal quantities of matter and antimatter and that it is governed by known physical laws. These questions are discussed further: the nature of the universe's evolution, and the manner in which matter and antimatter were separated and kept apart to form stable worlds. (L.B.S.)

20652 HOMOGENEOUS ANISOTROPIC COSMOLOGICAL MODEL WITH MAGNETIC FIELD. Shikin, I. S. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 171: 73-6(Nov. 1, 1966). (In Russian).

A homogeneous axially symmetrical solution of Einstein's gravitation equation and Maxwell's equations is considered for the case when space is filled with an ideal substance, and a magnetic field directed along the symmetry axis is present. The chosen co-moving system of space–time coordinates is one in which the substance is at rest. The co-moving system is at the same time synchronous, and the matter moves along geodetics. The presence of the magnetic field is manifest in the space–time geometry and greatly influences the character of the metric. The cases of closed and open models for dustlike matter are considered in detail. Parametric solutions are obtained for the open, the plane, and the closed models of the universe. The solution has the form of a trochoid in the presence of a magnetic field and a cycloid in the absence of a magnetic field. The constants of the parametric equations are determined. The results can be extended to include the case when there is no matter. (ATD)

20653 MAGELLANIC CLOUD STARS. Thackeray, A. D. (Radcliffe Observatory, Pretoria). Nature, 214: 136-7(Apr. 8, 1967).

The Magellanic Clouds, visible in the Southern Hemisphere, are the nearest external galaxies. Their brightest stars can be distinguished unambiguously with the spectroscope. A spectral survey of the 194 brightest known stars in the Large Magellanic Cloud has provided new information on the evolution of massive stars. Such short-lived supergiants should be seen close to their birthplace in the sky. (UK)

20654 MASER IN THE SKY. Cook, A. H. (National Physical Lab., Teddington, Eng.). New Sci., 6: 26-8(Apr. 1967).

Radio emissions from the hydroxyl molecule, detected within the past 18 months, show some remarkable features. They raise fascinating problems, particularly as it is very probable that stimulated emission occurs, as in masers and lasers. (UK)

20655 APPLICATION OF BISPECTRAL ANALYSIS TO A STUDY OF DIFFRACTION. II. Aubry, M. P. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). Ann. Astrophys., 30: 101-10(Jan.-Feb. 1967). (In French).

The problem of applying bispectral analysis to the diffraction of electromagnetic waves by the ionosphere is considered. This leads to studying successively the diffraction in two dimensions, the diffraction of unplanar wave fronts and the diffraction in an anisotropic medium. It is shown that the bispectral analysis of the field from a radiostar, diffracted by the ionosphere and then received on the ground, could theoretically yield information on the diffracting region (altitude and scale of the irregularities). (auth)

20656 SOME CHARACTERISTICS OF SOLAR RADIO BURSTS OF TYPE III AT LOW FREQUENCIES. Boischot, A. (Observatoire de Paris). Ann. Astrophys., 30: 85-91(Jan.-Feb. 1967). (In French).

Some characteristics of solar radiobursts of type III were determined from the sweep-frequency interferometer of the University of Colorado. The drift in frequency was measured in the range 40 to 8 MHz. The study of the damping rate of the emission shows a slow decrease of the coronal temperature with height, if it is assumed that this damping is collisional. (auth)

20657 CALCULATION OF NEUTRAL SODIUM LINES IN THE SOLAR SPECTRUM WITHOUT THE ASSUMPTION OF LOCAL THERMODYNAMIC EQUILIBRIUM. Chamaraux, Pierre (Observatoire de Paris). Ann. Astrophys., 30: 67-84(Jan.-Feb. 1967). (In French).

It is proposed to reproduce theoretically, without using the assumption of local thermodynamic equilibrium, central intensities and profiles of the sodium D lines in the solar spectrum. First it is shown that the results are little altered if only the first five discrete levels and the continuum are considered. The choice of fundamental data is discussed: atomic data, on the one hand; photospheric and chromospheric data on the other hand. Broad outlines of the method of resolution used, are given. From the results obtained—nonequilibrium parameter for each level, source functions, and profiles of optically thick lines—it is found that the source function of the D lines is collisionally dominated. The theoretical profiles of the D lines are compared with WADDELL's (1962a) and NEVEN's (1966) observations. The central intensities found—an important test for theory—are exactly the same as those of NEVEN, which confirms the excitation cross section of HAFT (1933) corrected by BATES (1962) for the 3s–3p transition; furthermore, the Doppler core of the profile is in good agreement with observation and provides clear evidence for UNNO's microturbulence model (1959); the agreement, not so good in the wings, can be greatly improved if the damping constant by collisions with neutral hydrogen atoms is multiplied by 1.5. The results obtained from a solar model without chromosphere lead to a complementary method for detecting stellar chromospheres. (auth)

20658 A STUDY OF GALACTIC SOURCES W 51 AND W 44. Kundu, M. R.; Velusamy, T. (Tata Inst. of Fundamental Research, Bombay). Ann. Astrophys., 30: 59-66(Jan.-Feb. 1967).

Observations of extended galactic sources W 51 and W 44 at 430 and 195 MHz with angular resolutions of 17′ and 35′ arc, respectively, are presented. It is found that at 430 MHz the source W 51 consists of four components. It has a mixed spectrum being composed of both thermal and nonthermal components. To the south of W 51, another extended source, WB 74, is observed. This source appears to have a thermal spectrum. The source W 44 has a nonthermal spectrum and is considered to be a supernova remnant. The shape of its contour map at 430 MHz is highly suggestive of a shell structure. It appears that like IC 443, the source W 44 is still evolving, the shell being formed only on the east side. Three other sources are observed in the region of W 44. (auth)

20659 DYNAMIC EFFECTS OF RADIATION PRESSURE IN H II REGIONS. Mathews, William G. (Univ. of California, San Diego, La Jolla). Astrophys. J., 147: 965-78(Mar. 1967).

It is shown that central holes in H II regions can be produced by the action of radiation pressure on the dust grains in the nebulae. The grains can be protected against sputtering for $\gtrsim 5 \times 10^5$ years by photoelectric charging. A dynamic model of the Rosette Nebula indicates that its age since ionization is between 2×10^5 and 6×10^5 years. (auth)

20660 RADIAL OSCILLATIONS IN A COMPRESSIBLE HOMOGENEOUS RELATIVISTIC MODEL. Navez, J. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 35: 711-26(1966). (In French).

The Rayleigh–Ritz method was used to derive successive approximations of the eigenfrequencies and eigenfunctions of the three first radial normal modes in the case of very-high-density homogeneous stars (e.g., neutron stars) or supermassive homogeneous stars (e.g., quasars). A comparison with the classical results is given. (auth)

20661 ROLE OF NEUTRINO IN ASTROPHYSICS. De Graaf, Tj. (Rijksuniversiteit, Groningen, Netherlands). Ned. Tijdschr. Natuur., 32: 329-46(Nov.-Dec. 1966). (In Dutch).

The different possible sources for the origin of the neutrino and the antineutrino in the universe are described. A review is given of the detection methods for high-energy neutrinos. The Fermi gases of low-energy neutrinos and antineutrinos are considered, and the astrophysical and cosmological consequences of these particles are discussed. (J.S.R.)

20662 THE GRAVITATIONAL INSTABILITY OF A UNIFORM, ROTATING, COLLAPSING CLOUD. Arny, Thomas T. (Amherst Coll., Mass.). Ann. Astrophys., 30: 1-11(Jan.-Feb. 1967).

The gravitational instability of a uniformly rotating, uniform density, collapsing cloud is studied. A linear perturbation analysis of the zero-pressure case shows that rotation hinders the growth of instabilities, with the amount of retardation depending on the product of the cloud and perturbation angular velocities. The use of the "point technique" indicates that while the nonlinear gravitational terms aid growth, nonlinear rotation terms, particularly the centrifugal force, inhibit fragmentation. The nonlinearity is most important for rapidly spinning perturbations in slowly rotating clouds. While differences are expected in the level of perturbation development between rotating and nonrotating systems, observations suggest that the dissimilar stellar content of elliptical and spiral galaxies cannot be attributed exclusively to this cause. (auth)

20663 VIBRATIONAL STABILITY OF PURE CARBON STARS. Noels-Groetsch, Arlette; Boury, A.; Gabriel, M. (Univ., Liege). Ann. Astrophys., 30: 13-21(Jan.-Feb. 1967). (In French).

Models for pure carbon stars were computed and their instability towards radial pulsations was investigated. The conclusions are strikingly different whether one takes the neutrino losses

into account or not. In the former case, the enhancement of the nuclear energy generation has such a destabilizing effect that no carbon burning star is stable, however small its mass. In the absence of neutrino losses, the stabilizing effect of the non-constant opacity coefficient is not counterbalanced and the critical mass, if it exists, is very high. (auth)

20664 NON-GRAY MODEL ATMOSPHERES OF SOLAR TYPE STARS. I. THE ROLE OF HYDROGEN MOLECULES AS A SOURCE OF CONTINUOUS OPACITY. Matsushima, Satoshi (Tokyo Univ. Univ. of Iowa, Iowa City). Ann. Astrophys., 30: 23-9(Jan.-Feb. 1967).

The relative importance of absorption by molecular hydrogen, (H + H), H_2^+, and H_2^- are examined for the ranges of temperature and pressure covering all spectral classes. The (H + H) absorption is found to be negligibly small in the atmospheres of all spectral classes. H_2^+ seems to produce appreciable absorption only in the blue or shorter wavelength regions of early-type stars, and H_2^- becomes significant only in the infrared region of the M-type stars. In view of the relatively small contribution of the molecular absorption, asymptotic expressions are derived for these absorption coefficients which should give sufficient accuracy for model atmosphere calculations. (auth)

20665 HYDROGEN LINES. I. QUASI-STATIC PROFILES IN STELLAR ATMOSPHERES. Praderie, F. (Observatoire de Paris). Ann. Astrophys., 30: 31-43(Jan.-Feb. 1967). (In French).

A grid of Hβ and Hγ line profiles was computed for model atmospheres covering the region of dwarfs to giants with reciprocal effective temperatures running from 0.7 to 1.1. A grid of P_{12} and P_{14} line profiles was also computed for a series of hot models (θ_{eff} = 0.55 to 0.70). The profiles were calculated using the quasi-static approximation for both ions and electrons, with the quasi-static electron density varying along each profile. (auth)

20666 HYDROGEN LINES. II. RESPECTIVE IMPORTANCE OF "IMPACT" DOMAINS AND QUASI-STATICS FOR ELECTRONS. Feautrier, Nicole; Praderie, Francoise; Van Regemorter, Henri (Observatoire de Paris). Ann. Astrophys., 30: 45-53(Jan.-Feb. 1967). (In French).

The failure of the approximate theories of Griem to describe properly the high-level hydrogen lines has led us from a computation of the contribution of quasi-static electrons to the broadening in a point of the profile. It is shown that the quasi-static region extends closer to the center than is indicated by the usual criteria. A semiclassical formulation of the electron-impact broadening of each Stark sublevel is given, and the regions of validity of the formulas generally used are determined. (auth)

20667 RAPID ROTATION OF THE SOLAR INTERIOR. Deutsch, Armin J. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Science, 156: 236-7 (Apr. 14, 1967).

A model proposed for the sun apparently can account for the maintenance of photospheric rotation against deceleration by the solar wind. The rotational period is about half a day near the top of the radiative mass, and 1.6 times shorter at the center. (auth)

20668 INTENSITY FLUCTUATIONS OF A RELATIVISTICALLY EXPANDING SOURCE. Petschek, Albert G. (New Mexico Inst. of Mining and Tech., Socorro). Science, 156: 239-40 (Apr. 14, 1967).

It is shown that the relation between the size of an object and the period of a fluctuation in its brightness must be modified if the surface whose brightness is fluctuating is expanding at a relativistic velocity, in the sense that faster fluctuations are possible for the expanding surface. (auth)

20669 QUASI-STELLAR OBJECTS: POSSIBLE LOCAL ORIGIN. Barnothy, J. M.; Terrell, James. Science, 156: 264-5 (Apr. 14, 1967).

Terrell (Science, 154: 1281(1966)) discussed the arguments favoring and contradicting the local-origin hypothesis of quasars and concluded that the galactic origin can account for all known characteristics of quasars. Two objections to Terrell's conclusions are raised by Barnothy and a brief discussion is given on each. Terrell answers Barnothy's objections in some detail and concludes that they are not valid. (W.D.M.)

20670 TRANSPORT PROCESSES IN THE PRIMORDIAL FIREBALL. Misner, C. W. (Cambridge Univ., Eng.). Nature, 214: 40-1(Apr. 1, 1967).

So far, it has not been possible to understand how galaxies could have developed from unstably amplified statistical fluctuations in an expanding universe which was initially homogeneous and isotropic, with the result that the view that the universe was once highly irregular is being reconsidered. An attempt is made to explain how certain finite initial perturbations could develop into galaxies and to present a view of the spectrum of initial irregularities and their subsequent development. It is interesting to look for truly dissipative effects associated with transport processes. It is shown that density variations of essentially all wavelengths up to the particle horizon are damped out as the universe cools to about 10^{10} °K from a singularly hot "big bang". The mechanism is the conduction of heat between the eγ gas (relativistic thermal electron–positron pairs and photons) and the gas of electron neutrinos. Density fluctuations must be considered in connection with primordial helium production. In the 10^{10} to 10^{11} °K epochs the neutrinos gave rise to very effective damping of acoustic waves, and it is pertinent whether this damping is also effective for gravitational waves. The effect of the neutrinos on eγ sound waves can be ascribed to an anomalous second viscosity of the fluid. The neutrinos transfer momentum as well as energy to the eγ gas, and hence damp shear velocities as well as compressional motions. Gravitational waves with wavelengths smaller than horizon size are not damped by neutrino viscosity. (UK).

20671 XENON–IODINE DATING: SHARP ISOCHRONISM IN CHONDRITES. Hohenberg, C. M.; Podosek, F. A.; Reynolds, John H. (Univ. of California, Berkeley). Science, 156: 233-6 (Apr. 14, 1967).

Measurements of the accumulation of ^{129}Xe from radioactive decay of extinct ^{129}I in meteorites show that the $^{129}I/^{127}I$ ratio in high-temperature minerals in diverse chondrites was 10^{-4} at the time of cooling. The uniformity in the ratio indicates that the minerals cooled simultaneously within 1 or 2 million years. (auth)

20672 MODEL ATMOSPHERES FOR LATE-TYPE STARS. Vardya, M. S.; Kandel, R. (Tata Inst. of Fundamental Research, Bombay. Observatoire de Paris). Ann. Astrophys., 30: 111-13 (Jan.-Feb. 1967).

Some of the problems and difficulties encountered in constructing model atmospheres for late-type stars are reviewed. The effects of both molecular and negative ion formation and of convection in transparent layers are considered. (auth)

20673 QUASAR 3C 446. Wesselink, A. J.; Hunter, J. Jr. (Yale Univ., New Haven). Science, 156: 103-4(Apr. 7, 1967).

During the second week of October 1966 a photographic patrol of 3C446 was initiated at the Bethany Observing Station of Yale Observatory, using the new 40-inch telescope. Preliminary data, covering a period of 2 months, are given which show significant variations in light over intervals of the order of one day. (W.D.M.)

20674 PROFILE OF THE UNIDENTIFIED INTERSTELLAR ABSORPTION BAND AT 4430 A AT DIFFERENT GALACTIC LONGITUDES. Seddon, H. (Royal Observatory, Edinburgh). Nature, 214: 257-9(Apr. 15, 1967).

The cause of the diffuse interstellar absorption band centered at 4430 Å is still unknown, 30 years after the recognition of its interstellar nature. Since this band, together with similar bands, can absorb as much visible energy from the radiation of distant stars as is absorbed by the visible Balmer lines, identification is of interest, and such identification may be critically dependent on a knowledge of the profile of the band. Investigation of the profile is difficult owing to its great width and small depth. Statistical evidence has been presented for correlation between the strength of 4430 Å absorption and the amount of interstellar extinction, and also for correlation between the ratio of 4430 Å colour excess strength and galactic longitude. This indicates a connection between the mechanism producing the 4430 Å absorption and that producing the general interstellar extinction. It has also been shown that changes in slope of the reddening law are markedly greater in the Perseus direction than in Cygnus and Cassiopeia, indicating a possible difference in physical constitution of the agent causing the extinction. It was therefore thought desirable to compare profiles of the 4430 Å band in these regions to see if there is an associated difference. Results are given. It is indicated that reddening and mean spectral types of the groups are approximately the same. Any apparent difference in the band profile in these galactic longitude regions was no greater than the experimental error. Whatever the connection between the causes of the 4430 Å band and the difference in the reddening discontinuity, it does not affect the profile of the band. The constancy of profile in regions of varying reddening may indicate a composite cause, only part of which is responsible for the 4430 Å band. (UK)

20675 EFFECT OF THE SOLAR ACTIVITY ON THE BRIGHTNESS AND POLARIZATION OF THE ZODIACAL LIGHT. Asaad, A. S. (Royal Greenwich Observatory, Hailsham, Eng.). Nature, 214: 259-60(Apr. 15, 1967).

Visual observations up to 1934 indicated that the Zodiacal light was changing with a period of two solar cycles. Such observations, however, were affected by the airglow and personal judgment. Seasonal variations have also been detected, and if these observations are plotted against the relative number of sunspots it is found that the brightness decreases with increasing solar activity. Analysis of photoelectric and photographic observations since 1950 gives similar indications. It has also been found that the brightness correlates with the solar wind velocity. Data also indicate that the polarisation tends to increase with solar activity. Possible explanations relate to force of the solar wind on interplanetary particles and alignment of particles by the magnetic fields. These mechanisms are discussed. (UK)

20676 OPTICAL VARIATION OF 3C 446. Cannon, R. D.; Penston, M. V. (Royal Greenwich Observatory, Hailsham, Eng.). Nature, 214: 256-7(Apr. 15, 1967).

It has been observed that the optical brightness of this quasar is variable. Observations during a programme of optical monitoring of quasars at the Royal Greenwich Observatory confirm this, and it is speculated that the variation is caused by occultation of the quasar by absorbing clouds in its vicinity. Observations of other quasars indicate that such continuous and large variations are rare. A further observation is that the light curve of 3C 446 shows a "flat top". It is suggested that 3C 446 consists of two, or possibly three, regions: a very compact region radiating optically by synchrotron or inverse Compton processes; possibly an intermediate region; and a larger region from which the emission lines originate. Decreases from maximum light are caused by absorbing clouds occulting the compact region. Estimates are made of the size and mass of the compact region, and of the cloud mass necessary to obscure this region completely. (UK)

20677 THE FAR-ULTRAVIOLET SPECTRA OF SIX STARS IN ORION. Morton, Donald C. (Princeton Univ. Observatory, N. J.). Astrophys. J., 147: 1017-24(Mar. 1967).

Far-ultraviolet spectra of δ, ϵ, ζ, η, ι, and κ Orionis were obtained with an f/2 objective spectrograph carried to 186 km by an Aerobee rocket on October 13, 1965. The lithium fluoride corrector of the Schmidt camera transmitted wavelengths longward of 1200 Å. An attitude-control system pointed the rocket toward ϵ Ori and then the limit-cycle jitter parallel to the dispersion was reduced by a passive gyroscopic stabilization system. Resolution was about 3 Å on a 180-sec exposure. Zero-order images of other stars in the field permitted an absolute calibration of wavelengths to about 1 Å. Emission lines of Si IV at 1402.8 Å and C IV at 1549.5 Å were identified in ϵ and ζ. Strong absorption lines of both components of the Si IV doublet and the unresolved C IV doublet were found in ϵ, ζ, and ι shifted to shorter wavelengths by velocities of 1800, 1900, and 3800 km sec^{-1}, respectively. The Si IV doublet was present in δ shifted in the same direction by 1400 km sec^{-1}. These displaced resonance absorption lines must be formed in gas escaping from the stars at high velocities, indicating mass loss from these giants and supergiants. Absorption lines about 9 Å wide are also visible at 1216 Å in δ and ζ and are attributed to Lyman-α absorption by interstellar hydrogen atoms. For broadening by radiation damping this width corresponds to $\sim 1.5 \times 10^{20}$ atoms cm^{-2} in the line of sight. This is about one-tenth the density found from the 21-cm radio emission in this direction. (auth)

20678 MEASUREMENTS OF THE LINEARLY POLARIZED COMPONENTS OF RADIO SOURCES AT A WAVELENGTH OF 3.75 CM. Hobbs, R. W.; Haddock, F. T. (Univ. of Michigan, Ann Arbor). Astrophys. J., 147: 908-11(Mar. 1967).

The linearly polarized component of 22 radio sources was studied at a wavelength of 3.75 cm (8 GHz) using the 85-foot reflector of the University of Michigan. The degree of polarization and position angle are given for seven galactic and fifteen extragalactic sources. (auth)

20679 SPECTROPHOTOMETRIC OBSERVATIONS OF RAPID VARIABILITY IN 3C 279 AND 3C 446. Oke, J. B. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 147: 901-7(Mar. 1967).

The prime-focus spectrum scanner was used to make photoelectric spectrophotometric observations of the variable quasi-stellar sources 3C 279 and 3C 446. In the case of 3C 279, substantial brightness changes of the continuum, including a change of 0.25 mag in an interval of 24 hours, were found. The visual magnitude has varied by nearly 2 mag during the last year. Observations of 3C 446 covered a 5-day interval following the outburst in June, 1966, and indicated that the continuum was becoming fainter at a rate of 0.1 mag per day. In both objects the continuum became redder when the brightness was less. In 3C 446, however, the continuum color during the outburst was much redder than it had been when faint in 1965. The absolute strengths of λ2798 of Mg II in 3C 279 and λ1550 of C IV in 3C 446 remain constant independent of any change in the continuum. While the rapid light variations of the continuum imply dimensions of the order of 3×10^{16} cm, the region which produces the emission lines must be much larger, and conventional models with dimensions of 1 pc or more can apply. (auth)

20680 POSSIBLE THERMAL HISTORIES OF INTERGALACTIC GAS. Weymann, Ray (Univ. of Arizona, Tucson). Astrophys. J., 147: 887-900(Mar. 1967).

By using simple expressions to represent the time dependence of the heating of intergalactic gas, the thermal history of an initially cold gas is followed and the resulting radiation field is computed. If one requires that the gas must have been strongly heated and ionized at a redshift of about 2 to avoid strong Ly-α absorption in the spectra of QSO (here assumed to be cosmologically distant) then, at a final gas density of the order of $10^{-5}/cm^3$, inadmissibly large amounts of x-ray emission in the 5 to 10-Å region can be avoided only for a very narrow range of heating parameters. Measures at 25 to 30 Å with comparable sensitivity would be decisive. Models with a high degree of clumpiness in the gas can already be excluded. Koehler's reported value of an intergalactic hydrogen density of $n_H \sim 10^{-7}$ cannot be reconciled with any of the models investigated, and it appears that one either has to drop the assumption of cosmological distances for the QSO or else consider a model in which the ionization is caused by a burst of star formation in the early stages of galaxy formation. However, a specific model of this type, assuming stars of T_{eff} = 21000°K encounters the difficulty that the total light from the galaxies at this epoch should be far more intense than the observations allow. (auth)

20681 ARE YOUNG GALAXIES VISIBLE? Partridge, R. B.; Peebles, P. J. E. (Princeton Univ., N. J.). Astrophys. J., 147: 868-86(Mar. 1967).

The purpose is to assess the general possibility of observing distant, newly formed galaxies. To this end a simple model of galaxy formation is introduced. According to the model, galaxies should go through a phase of high luminosity in early stages of their evolution. The estimated luminosity for a galaxy resembling our own is $\sim 3 \times 10^{46}$ ergs/sec, roughly 700 times higher than the present luminosity. The bright phase would occur at an epoch of about 1.5×10^9 years, corresponding to a redshift between 10 and 30, depending on the cosmological model assumed. The possibility of detecting individual young galaxies against the background of the night sky is discussed. Although the young galaxies would be numerous and would have sufficiently large angular diameters to be easily resolved, most of the radiation from the young galaxies would arrive at wavelengths of 1 to 3 μ where detection is difficult. However, it seems possible that the Lyman-α line might be detected if it is a strong feature of the spectra of young galaxies. It is also shown how such an experiment might help to distinguish between various cosmological models. (auth)

20682 COSMOLOGICAL DISTORTION EFFECT. Kristian, Jerome (Univ. of Wisconsin, Madison). Astrophys. J., 147: 864-7(Mar. 1967).

Detailed equations for the effect are given, and an unsuccessful attempt to measure it on 200-inch photographs of clusters of galaxies is described. The results give an upper limit of 2×10^{-18} yr^{-2} for all components of the incident magnetic-type gravitational field and 0.6×10^{-18} yr^{-2} for at least some of them. These numbers are not very stringent tests of the Friedmann and steady-state models, but seem to be about the best that can be done with this kind of measurement. (auth)

20683 GRAVITATIONAL INSTABILITY OF THE UNIVERSE. Peebles, P. J. E. (Princeton Univ., N. J.). Astrophys. J., 147: 859-63(Mar. 1967).

It is argued that the expanding universe is unstable against the growth of gravitational perturbations. The argument is directed toward two problems: the physical conditions in the early, highly contracted phase of the expanding universe, and the formation of the galaxies. (auth)

20684 EXISTENCE OF INTERMEDIATE WAVES IN NEUTRAL SHEETS. Petschek, H. E.; Thorne, Richard M. (Avco-Everett Research Lab., Everett, Mass.). Astrophys. J., 147: 1157-63(Mar. 1967).

Green and Sweet have questioned the resolution of neutral sheets into standing waves on the basis that they appear to require inadmissible slow shocks. It was suggested earlier by Kantrowitz and Petschek that such situations in general magnetohydrodynamic flows can be resolved by a combination of slow and intermediate waves. Several specific cases for neutral sheet configurations

are demonstrated to give consistent solutions when the additional waves are taken into account. (auth)

20685 POSSIBILITY OF SEARCHING FOR QUARKS BY RADIO-ASTRONOMICAL TECHNIQUES. Fazio, G. G.; Zuckerman, B. Astrophys. J., 147: 1196-9(Mar. 1967).

A possible region where quarks can accumulate over long intervals is interstellar space, since their lifetime against annihilation is long. In such a region it is possible for a p-type quark ($Q = +\frac{2}{3}$), moving with thermal velocity, to capture an electron and form a bound system of total net charge $-\frac{1}{3}$. It has been suggested that a search for such a bound quark–electron system by means of radio-astronomical techniques would be worthwhile. It was thought that the ground-state hyperfine transition equivalent to the well-known 21-cm line of the hydrogen atom could be detected. It is concluded that even if quarks do exist, their detection by this method is extremely improbable. The problems inherent in such an undertaking are mentioned, and the frequency, strength, and width of the hyperfine line are discussed. (W.D.M.)

20686 THE BEHAVIOR OF RU CAMELOPARDALIS AS AN EXAMPLE OF OSCILLATION HYSTERESIS. Whitney, Charles A. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 147: 1191-3(Mar. 1967).

During an interval of several months in 1964, the variable star RU Cam virtually ceased its pulsation. Ru Cam had been observed as a variable star on plates exposed as early as 1899, and although it has been difficult to classify unambiguously, this star had several of the characteristics of W Virginis stars. Its period of 22 days showed slight fluctuations, but its light curve was quite stable and the phase relation between light and velocity variation is typical of W Virginis stars. Qualitative comments on the abrupt cessation of pulsation are presented. (W.D.M.)

20687 HYDROGEN CONVECTION ZONES AND STELLAR ROTATION. Demarque, P.; Roeder, R. C. (Univ. of Toronto). Astrophys. J., 147: 1188-91(Mar. 1967).

O. C. Wilson (1966) made an attempt to connect the rotation of stars with their chromospheric properties and presence of an outer convection zone. Additional evidence supporting Wilson's interpretation of his observations is brought forth. It is drawn from recent calculations of stellar structure and bears on the position and shape of the boundary line between fast and slow rotators in the c_1 versus $(b-y)$ diagram, and on observations of H and K emission features. (W.D.M.)

20688 THE EXISTENCE OF MAGNETIC FIELDS IN TWO PECULIAR B STARS IN ORION. Sargent, Wallace L. W.; Sargent, Anneila I.; Strittmatter, Peter A. (Univ. of California, San Diego). Astrophys. J., 147: 1185-8(Mar. 1967).

Five early B-type stars in the Orion I Association have been found to possess abnormally weak He I lines for their intrinsic colors and for their spectral types as judged from lines of other elements. In an attempt to determine if these stars have measurable magnetic fields, spectrograms of HD 37058 and HD 36629 were obtained with the Zeeman analyzer at the coudé spectrograph of the Lick Observatory 120-inch telescope. In both cases, positive evidence was found for a magnetic field. It was found that for HD 37058, $H_e = +2500 \pm 300$ gauss, and for HD 36629, $H_e = +1400 \pm 300$ gauss, where H_e is the line-of-sight component of the field averaged over the surface of the star. (W.D.M.)

20689 NUMERICAL EXPERIMENTS WITH A ONE-DIMENSIONAL MODEL FOR A SELF-GRAVITATING STAR SYSTEM. Hohl, Frank; Feix, Marc R. (Langley Research Center, Hampton, Va. College of William and Mary, Williamsburg, Va.). Astrophys. J., 147: 1164-80(Mar. 1967).

Computer experiments with a one-dimensional model were performed to trace the evolution of stellar systems. The nonstationary equilibrium state for a one-dimensional system of stars computed for an interesting class of initial conditions is found to correspond to a minimum energy configuration. The results of the numerical experiments are compared with theory. For initial energies far from the minimum equilibrium energy the system becomes unstable and breaks up into smaller clusters. The one-dimensional model is of interest as an approximation to the distribution of velocity and mass normal to the galactic plane of a highly flattened galactic system. (auth)

20690 MEASUREMENT OF THE ABUNDANCE OF ^{41}Ca IN THE GRANES METEORITE. Bibron, Roland; Leger, Concele; Mabuchi, Hisao; Tobailem, Jacques (Centre d'Etudes Nucleaires, Saclay, Gif-sur-Yvette, France. CNRS, Gif-sur-Yvette, France). Compt. Rend., Ser. D, 264: 533-5(Jan. 23, 1967). (In French).

The calcium 41 in a meteorite (Graves chondrite) can be measured, using an x-ray spectrometer, by its own very weak activity. The activity found was 4.3 ± 2.6 dpm per kilogram of meteorite. (tr-auth)

20691 THE INFRARED POLARIZATION OF THE INFRARED STAR IN CYGNUS. Forbes, Fred F. (Univ. of Arizona, Tucson). Astrophys. J., 147: 1226-9(Mar. 1967).

In an effort to obtain far-infrared data on the wavelength dependence of polarization, a new infrared polarimeter was developed at the Lunar and Planetary Laboratory, thereby extending the polarization measurement capability to 3.4 μ. Of the two extremely red stars reported by Neugebauer et al. (1965), the one in Cygnus was discovered to be significantly polarized at 1.62 and 2.2 μ, while the polarization of the Taurus object is indistinguishable at 1.25, 1.62, and 2.2 μ from that of seven standard unpolarized stars. A sharp decrease in the polarization of the Cygnus object from 2.2 to 3.4 μ was detected. Observations were made in Nov. and Dec. 1966. The apparatus, calibration, and results are described. (W.D.M.)

20692 QUASI-STELLAR OBJECTS IN UNIVERSES WITH NON-ZERO COSMOLOGICAL CONSTANT. Petrosian, V.; Salpeter, E.; Szekeres, P. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 147: 1222-6(Mar. 1967).

About 60 quasars with measured red shifts $z = \Delta\lambda/\lambda$ are now known. It has been pointed out that the cosmological interpretation of the red shift seems to lead to discrepancies with the observations if the more usual cosmologies with a zero value of the cosmological constant λ are used. First, the observed apparent optical magnitude M_v does not increase rapidly enough with increasing z. Second, a preponderance of sources with z near 2.0 has been observed. It is pointed out here that these discrepancies are not necessarily present in closed-model universes with a substantially non-zero value of the cosmological constant. It is shown that the two discrepancies are reversed in some models. These models can also lead to "ghost images" whose predicted properties are discussed. (W.D.M.)

20693 ON SOME COINCIDENCES BETWEEN WAVELENGTHS OF ABSORPTION FEATURES IN HZ 29 AND IN QUASI-STELLAR OBJECTS. Burbidge, G.; Burbidge, M.; Hoyle, F. (Univ. of California, San Diego. Cambridge Univ., Eng.). Astrophys. J., 147: 1219-21(Mar. 1967).

It has been recently pointed out that there are a considerable number of remarkable coincidences in the measured positions of the absorption lines in the spectra of several quasars. In an attempt to add further to this strange situation, some coincidences between wavelengths of absorption features in HZ 29 and in quasars 3C 191 and PKS 0237-23 are detailed. Various hypotheses are enumerated any of which being correct would require a radically new approach to the nature of the redshifts of the quasars. (W.D.M.)

20694 PHYSICAL CHARACTERISTICS OF SCO X-1. II. Johnson, Hugh M. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Astrophys. J., 147: 1213-18(Mar. 1967).

A family of models of some physical characteristics of Sco X-1 has been discussed previously by the author. Those results are used to discuss ionization in the x-ray source, and the possibility of a stellar wind is introduced. (W.D.M.)

20695 X-RAY SPECTRA OF SEVERAL COSMIC SOURCES. Fisher, Philip C.; Jordan, Willard C.; Meyerott, Arthur J.; Acton, Loren W.; Roethig, Douglas T. (Lockheed Palo Alto Research Lab., Calif.). Astrophys. J., 147: 1209-13(Mar. 1967).

On September 30, 1965, rocket-borne gas proportional counters were used to locate x-ray sources at low galactic latitude and longitude and to determine their spectra. The spectra for five of these sources are presented. The spectral distributions and fluxes were derived from the data obtained with two different observations of a single source. The data are restricted to x-rays more energetic than 2.5 keV and less energetic than 16 keV. The five new measurements of spectral distributions appear quite similar to each other and the shapes of these distributions are intermediate to the extremes represented by the spectra of the Crab Nebula and the brightest x-ray source Sco X-1. (W.D.M.)

20696 LYMAN-ALPHA EMISSION FROM THE SUN NEAR SOLAR MINIMUM. Weeks, L. H. (GCA Corp., Bedford, Mass.). Astrophys. J., 147: 1203-5(Mar. 1967).

Additional data are reported which give more information on the Lyman-α fluxes at solar minimum and one value for 1966 for more active conditions. Several sounding rocket programs for the IQSY utilized Lyman-α ion chambers for the purpose of measuring molecular oxygen above 70 km. Since these ion chambers were calibrated prior to flight, they also provided useful data on the incident Lyman-α flux, and these new results are presented. (W.D.M.)

20697 THE HYDROGEN AND HELIUM CONTENT OF EXTREME POPULATION-I OBJECTS. Percy, John R.; Demarque,

Pierre (Univ. of Toronto. Univ. of Chicago). Astrophys. J., 147: 1200-2(Mar. 1967).

Recent observations of 3°K isotropic background radiation and subsequent theories of the early history of the Universe have aroused new interest in the hydrogen and helium content in stars. The fractional abundance by weight of hydrogen(X) for extreme Population-I objects is considered. This value of X presumably represents an important lower limit for the corresponding value for the old Population-II objects. Both direct and indirect determinations of the hydrogen and helium contents are discussed. (W.D.M.)

20698 NOTE ON THE DISSIPATION OF MAGNETIC FIELDS AT NEUTRAL LINES. Green, R. M. (Univ. of Glasgow); Sweet, P. A. Astrophys. J., 147: 1153-6(Mar. 1967).

It is shown to be impossible, in general, to have a steady flow of a gas with finite electric conductivity in the neighborhood of a neutral line in a two-dimensional field with two simple intersecting stable slow-mode shocks as in the Petschek mechanism. (auth)

20699 CORRECTING SOLAR-FLARE DATA. Sawyer, Constance (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Astrophys. J., 147: 1135-52(Mar. 1967).

An exploratory effort to combine solar-flare measurements made at various observatories and to reduce reported values of importance and area to standard scales is described. From July, 1955, through December, 1961, some 50 different observatories supplied about 70,000 flare reports. These were grouped and merged into a single description of each flare with the help of an electronic computer. The machine provides satisfactory grouping of all reports except a few that pertain to large, long-lasting, complex flares. Examination of mean reported values of importance and area confirms the existence of systematic errors that depend on Universal Time and on flare position, but shows that the scales are reasonably constant from year to year and that importance ratings of central flares are generally consistent with area values. For each observatory a set of corrections to reported values of importance and apparent area was determined. These corrections are functions of reported importance or area and of central distance. Corrections were sought that would give a flare rate uniform through the Universal Day and in central meridian distance and at the same time would keep average importance and area scales constant and improve agreement among reports of a given flare. Present progress in attaining these goals is evaluated, and future growth and improvement of the program are outlined. (auth)

20700 THE SUN'S POLAR SURGES AND MAGNETIC FIELDS. Godoli, G.; Mazzucconi, F. (Arcetri Astrophysical Observatory, Florence). Astrophys. J., 147: 1131-4(Mar. 1967).

Although, according to the Menzel–Evans classification of solar prominences, bright surges at the limb (BSL) should be typical phenomena of the activity centers, observations show the existence of polar BSL. During the period July 1, 1957, to December 31, 1964, 6% of the observed surges were polar (latitude >50°). It is shown that the polar BSL have been more frequent at the minimum of solar activity where (1) the intensity of the polar magnetic fields reaches maximal values; (2) the polar faculae are more frequent; (3) the polar coronal rays are visible. (auth)

20701 OBSERVATION OF THE SOLAR LINE OSCILLATIONS WITH AN ATOMIC-BEAM SPECTROPHOTOMETER. Roddier, F. (Faculte des Sciences, Nice, France). Astrophys. J., 147: 1113-16(Mar. 1967).

An atomic-beam resonance spectrophotometer was used with the McMath solar telescope to observe the 300-sec oscillation of velocity in photospheric granules. The Sr λ4607 line profile periodically changes between a symmetric profile at the expected wavelength and an asymmetric one shifted to the violet. (auth)

20702 CENTER-TO-LIMB VARIATIONS OF THE INTENSITY AND THE WAVELENGTH OF SEVERAL FRAUNHOFER LINES ALONG THE SUN'S POLAR AND EQUATORIAL DIAMETER. Appenzeller, I. (Univ. of Chicago); Schroeter, E. H. Astrophys. J., 147: 1100-5(Mar. 1967).

The center-to-limb variations for the continuum, for two faint iron lines, and for the cores of several strong Fraunhofer lines were measured along polar and equatorial diameters of the solar disk. A photoelectric device was used attached to the Gregory-coudé solar telescope of the University Observatory, Göttingen, at Locarno. The temperature difference between the polar and the equatorial limb was found not to exceed 6°K during August, 1965. Simultaneous recordings of the variations of the wavelength were used to determine the so-called limb effect on these lines. (auth)

20703 THE VELOCITY-DEPENDENT NON-LTE SOURCE FUNCTION. I. DISCONTINUOUS VELOCITY–SEMI-INFINITE ATMOSPHERE. Kulander, John L. (General Electric Co., Valley Forge, Pa.). Astrophys. J., 147: 1063-84(Mar. 1967).

The depth variation of the non-LTE line source function $S_l(\tau)$ is obtained in an atmosphere containing a discontinuous ordered velocity directed along the normal to the surface. A single velocity discontinuity at arbitrary depth τ_1, with uniform velocities above and below τ_1, is considered. The assumed isothermal, constant-density atmosphere consists of particles having only two discrete energy states. The Eddington approximation to the transfer equation is employed in obtaining the numerical solutions. Distinct limiting types of behavior appear in $S_l(\tau)$ for large and small τ_1. Emergent line profiles are compared with those obtained using various forms of the source function valid in a stationary two-layer atmosphere. Results for a wide range of velocities and ratios of continuum to line opacities r_l, provide information which can be used for the qualitative interpretation of spectra formed under diverse physical conditions. (auth)

20704 NUCLEAR REACTIONS DURING STELLAR COLLISIONS. Mathis, John S. (Univ. of Wisconsin, Madison). Astrophys. J., 147: 1050-62(Mar. 1967).

Calculations are presented representing a direct encounter between two solar-type stars. The collision is assumed to have a zero impact parameter which, by symmetry, is equivalent to the collision of a star with an immovable mirror across which no mass or radiative flux can flow. Two speeds of the stars at infinity, 0 and 389 km/sec relative to the mirror, are assumed. These speeds bracket the observed velocity dispersions in the nuclei of galaxies. The problem is reduced to a one-dimensional hydrodynamic calculation by an approximate treatment of the motions parallel to the mirror. The temperature along the axis of the collision reaches 1.0×10^{8}°K for about 100 sec and then cools quickly. Nuclear reactions are not sufficient by a large amount to appreciably alter the chemical composition and the nuclear energy generated is also always small in comparison to the hydrodynamic work. The calculations are not very reliable about the amount of mass expelled but indicate it is of the order of a tenth of the mass or less. (auth)

20705 AN ANALYSIS OF CH IN THE SOLAR ATMOSPHERE. Withbroe, George L. (Univ. of Michigan, Ann Arbor). Astrophys. J., 147: 1117-30(Mar. 1967).

Center-limb observations of selected lines in the $^2\Delta - ^2\pi$ band system of the CH molecule are used to study the upper photosphere. The observations are interpreted using several photospheric models including an inhomogeneous three-stream model. As a first approximation the assumption of LTE appears to be adequate for the CH lines. A turbulence model was deduced from the center-limb behavior of the CH equivalent widths and the profile of λ4248.944 Å. For the microturbulence in the upper photosphere, $-2.5 \leq \log \tau_{5000} \leq -0.5$, a radial velocity of 1.2 ± 0.2 km/sec and a ratio between the tangential and radial components of 1.2 ± 0.2 were found. For the macroturbulence in the same layers a radial component of 1.0 ± 0.5 km/sec and a tangential component of 1.7 ± 0.5 km/sec were found. (auth)

20706 CERTAIN LAWS OF CONCENTRATION DENSITY OF STARS AND GALAXIES. Gadjokov, V.; Kalinkov, M. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 121-42(1966). (In Russian).

The inverse problem to the subject of the spatial structure of stars and galaxies, which consists in finding the surface density beginning with a given spatial density, was examined. Three distribution laws were analyzed. The first law is ordinary but can be used for the approximate calculation of the simple density. The second law can be integrated directly but the third, the generalized Wallenquist law, was integrated numerically on a computer. (tr-auth)

20707 THE AVERAGE PROFILE OF THE SOLAR K LINE DURING THE SUNSPOT CYCLE. Sheeley, N. R. Jr. Astrophys. J., 147: 1106-12(Mar. 1967).

Measurements of the fraction of the solar disk covered by bright K_2 emission at various phases of the sunspot cycle are presented together with measurements of the K_2 emission intensity of various solar features. It is estimated that at the time of the last sunspot maximum approximately 20% of the visible disk was covered by K_2 emission with intensity at least three times that of the quiet disk. This corresponds to a 40% increase in the average intensity of K_2 emission at the time of sunspot maximum over the average intensity at the time of sunspot minimum. A smaller variation associated with solar rotation is also estimated. Average K spectra for the separate hemispheres of the sun, as they currently appear, are presented. These spectra show considerable differences which are attributed to the differences in solar activity presently existing in the two hemispheres. It is concluded that, if one regards the sun as a point source of light, as it would appear from the vicinity of a

distant star, there would be a significant variation in the intensity of its K_2 emission with time corresponding to the variation of the sunspot number with time. This result emphasizes the possibility of finding "sunspot cycles" in stars by observing the intensity of K_2 emission. (auth)

20708 THE LAW OF INTERSTELLAR EXTINCTION FOR EMISSION NEBULAE ASSOCIATED WITH O-TYPE STARS. Johnson, H. L. (Univ. of Arizona, Tucson). Astrophys. J., 147: 912-16(Mar. 1967).

UBVRIJKL photometric observations were made for a number of O-type stars associated with emission nebulae. The interstellar-extinction curve for Herschel 36, in NGC 6530, is very similar to that for the Orion Trapezium region. Of the stars that have so far been observed, no others possess such extinction curves. The stars in NGC 2244 were reobserved, confirming the earlier results and the turnup of the extinction curve between K and L for this cluster. (auth)

20709 ANALYSIS OF F AND G SUBDWARFS. I. THE LOCATION OF SUBDWARFS IN THE THEORETICAL H-R DIAGRAM. Strom, S. E. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.); Cohen, J. G.; Strom, K. M. Astrophys. J., 147: 1038-49(Mar. 1967).

Spectrum scans and model stellar atmospheres were used to locate in the ($L/L_\odot$, T_{eff}) plane F and G subdwarfs having known parallax. A comparison is made between their position on the H-R diagram and the evolutionary tracks for Population-II models of low- and high-helium content recently computed by Faulkner and Iben. The lower helium-content models are found to give somewhat more plausible ages than the high-helium models. Nevertheless, for both the low- and high-helium-content models, several subdwarfs with ages apparently greater than 10×10^9 years were found. (auth)

20710 ISOTROPY OF COSMIC BACKGROUND RADIATION AT 10690 MHz. Conklin, E. K.; Bracewell, R. N. (Stanford Univ., Calif.). Contract AF49(638)-1375. Phys. Rev. Lett., 18: 614(Apr. 10, 1967).

An experiment, using a 60-ft paraboloid antenna, which had as its object the discovery of features of small angular size in the cosmic background radiation is described. It was concluded that the background radiation, if it exists, is structureless, in the region observed, to less than ⅛ of 1% on an angular scale of the order of 1°. (W.D.M.)

20711 LITHIUM IN β HYDRI AND OTHER STARS. Feast, M. W. (Radcliffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc., 134: 321-26(1966).

The old subgiant β Hyi, a member of the ζ Her group, has a lithium/calcium abundance ratio ten times the solar value. The $^6Li/^7Li$ isotope ratio is also high ($R' = 0{\cdot}45$). Evidence is presented which suggests that in lithium-rich solar-type stars the $^6Li/^7Li$ ratio is generally high for subgiants and low for stars on the main sequence. This implies that some lithium production occurs between the main sequence and the subgiant phases. The old, late-type, subgiant δ Eri, which appears to have an approximately solar abundance of lithium and a low $^6Li/^7Li$ ratio, could have evolved from a lithium-rich solar-type subgiant. (auth)

20712 LINEAR POLARIZATION OF THE GALACTIC RADIO EMISSION AT 1407 Mc. Bingham, R. G. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 134: 327-45(1966).

A survey of the linearly polarized component of the galactic radio emission was made at a frequency of 1407 Mc for declinations above −1°. The beamwidth of the aerial used was 2° between half-power points. The results are presented as maps in both equatorial and galactic co-ordinates. The principal features are (i) a smooth variation with direction as compared with the surveys at lower frequencies and (ii) strong polarization from the region of the North galactic Spur. The maximum polarization temperatures found are about 0.5 to 0.7°K. (auth)

20713 MARCH WITH DEPTH OF MOLECULAR ABUNDANCES IN THE OUTER LAYERS OF K AND M STARS. Vardya, M. S. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo. Sterrewacht Sonnenborgh, Utrecht). Mon. Notic. Roy. Astron. Soc., 134: 347-70(1966).

A program has been developed for computing the equilibrium concentration of one hundred molecules, atoms, and positive and negative ions, formed out of fifteen elements. This program, coupled with the programs for computing mean opacities and for model atmospheres, was used to determine the abundances of various molecules as a function of optical depth in K and M spectral type stars. Several new compounds were found which may play significant roles in late-type stars. A careful comparison of the march of molecular abundances in different spectral types reveals why certain molecules, even though sufficiently abundant in a certain layer of a given star, may be observed only in earlier or later spectral type stars than that of the given star. (auth)

20714 RADIO SPECTRA OF SOURCES IN THE FOURTH CAMBRIDGE CATALOGUE. Long, R. J. (Univ. of Manchester, Eng.); Smith, M. A.; Stewart, P.; Williams, P. J. S. Mon. Notic. Roy. Astron. Soc., 134: 371-88(1966).

Measurements made at 38, 178, 617, and 1417 Mc were combined to examine statistically the spectral properties of virtually all sources whose quoted flux densities in the Fourth Cambridge Catalogue are greater than, or equal to, 5×10^{-26} watts m^{-2} $(c/s)^{-1}$, and which lie between 20° and 40° declination. (auth)

20715 MODELS OF THE GALACTIC MAGNETIC FIELD. Seymour, P. A. H. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc., 134: 389-403(1966).

The variation of Faraday rotation measure with galactic co-ordinates is derived for various simple models of the galactic magnetic field. It is assumed throughout that the Faraday rotation takes place in the galaxy as a whole. To compare the data with the models, a spherical harmonic expansion of the available observations of rotation measure for extragalactic radio sources is carried out. Comparison between the harmonic analysis and the predictions of the models leads to the following conclusions. The galactic magnetic field has an equatorially symmetric toroidal component that increases with distance from the galactic axis of rotation. The boundary of this component is a slightly flattened ellipsoid. There is also a weaker equatorially antisymmetric toroidal component in the halo. The analysis supports the assumption that the Faraday rotation is not confined to the local spiral arm. (auth)

20716 HYPOTHESIS OF GALACTIC COLLISIONS AS AN EXPLANATION OF THE COUNTS OF RADIO SOURCES. Davidson, W.; Davies, M. (Battersea Coll. of Tech., London). Mon. Notic. Roy. Astron. Soc., 134: 405-17(1966).

An attempt is made to fit a five-parameter family of evolutionary universes to the number counts of radio sources, on the hypothesis that the radio sources originate in the collision of galaxies. In accordance with this hypothesis it is assumed that the spatial density of radio sources is proportional to the square of that of ordinary galaxies at all epochs. It is found that the actual number count curve can be fitted reasonably closely for certain restricted values of the parameters. However, all models giving a satisfactory fit have the severe shortcoming that they permit no radio sources to exist which have a red shift exceeding 2.1. In the case of the Einstein-de Sitter model the limiting red shift is only 1.72, which is less than the measured red shifts of several recently identified quasars. This and other evidence indicates strongly that the origin of radio sources does not lie in the collision of galaxies. (auth)

20717 DECAY OF STELLAR MAGNETIC FIELDS. Roxburgh, I. W.; Suffolk, G. C. J. (London Univ.). Contract AF 61(052)-908. Z. Astrophys., 66: 1-5(1967).

Eigenvalues are calculated for the decay of toroidal magnetic fields having different geometries. The decay times of several modes are compared with results obtained by WRUBEL (1952) for poloidal magnetic fields. It is shown that the decay time of a toroidal magnetic field is less than that of the corresponding poloidal field. The resulting toroidal decay fields are presented. (auth)

20718 MASS SPECTRUM OF INTERSTELLAR CLOUDS. Scheffler, H. (Landessternwarte, Heidelberg). Z. Astrophys., 66: 33-44(1967). (In German).

The mass spectrum of interstellar clouds represented by $p(M) \sim M^{-\delta}$ is derived from recent empirical results (1) on the relation between visual absorption values and diameters of the clouds and (2) on the frequency distribution of their visual absorption values as well as optical depths at $\lambda = 21$ cm. It is found that $\beta = 2 \pm 0.2$ for $M < 5 \cdot 10^3$ $M_\odot$ resp. $\beta = 1 \ldots \frac{3}{2}$ for $M > 5 \cdot 10^3$ $M_\odot$; the mass of a typical small cloud (visual absorption 0^m26, optical depth at $\lambda = 21$ cm about 0.5 ... 0.7, diameter ≈ 3 pc) is found to be 20 ... 30 $M_\odot$. Several arguments quoted are in favor of the conclusion that typical large clouds (average diameter ≈70 pc) are loose complexes consisting of compact clouds with diameters mainly of ≈20 ... 30 pc and masses of at most some 10^4 $M_\odot$. Excluding these cloud complexes one obtains $\beta \approx \frac{3}{2}$ for $M > 5 \cdot 10^3$ $M_\odot$ and approximately the same densities of ≈60 ... 80H atoms/cm^3 for all clouds. The interpretation of these results by recent attempts at statistical dynamics of the interstellar matter by Field and Saslaw (1965) is discussed. (auth)

20719 EVOLUTION OF A DOUBLE STAR SYSTEM. II. FORMATION OF WHITE DWARFS BY MASS EXCHANGE. Kip-

penhahn, Rudolf; Kohl, Klaus; Weigert, Alfred (Univ., Goettingen, Ger.). Z. Astrophys., 66: 58-79(1967). (In German).

Computations were carried out for the evolution of a star of $M_1 = 2M_\odot$ in a close binary system; the original secondary component of the system has $M_2 = 1M_\odot$ and a distance of $6.6R_\odot$. The primary fills its Roche surface after the exhaustion of hydrogen in the central core. Then a phase of mass loss starts, after which the star has lost most of its hydrogen rich envelope, in agreement with the results in the first paper of this series. At the end of the mass loss, $M_1 = 0.264M_\odot$. This star does not ignite helium burning in the center, since the final mass is too low. Instead, the star's interior practically stops to contract because of high degeneracy and it cools down. The outer parts of the star contract very much and the star becomes a white dwarf. Since this whole evolution is rapid enough, finally a system of a white dwarf together with a practically unevolved companion of $M_2 = 2.736\ M_\odot$ results. The white dwarf is still inhomogeneous, having a hydrogen rich envelope of 0.9% of the total mass. The shell source at the boundary of this envelope becomes thermally unstable in the last model. The conditions are derived, which are necessary for an unevolved system in order that the primary will become a white dwarf due to mass exchange. (For instance, the mass of the primary should be smaller than $2.8\ M_\odot$.) These conditions turn out to be not very restricting for the occurrence of this type of evolution. The system V 477 Cyg is shown to be one of the examples for detached systems fulfilling these conditions. (auth)

20720 RELATIVISTIC COSMOLOGY. Pachner, Jaroslav. Pokroky Mat. Fys. Astron., 11: 348-63(1966). (In Czech).

A review is presented of the development of relativistic cosmology with a historical introduction which starts with the three paradoxes of Newtonian cosmology and traces the development up to the present day. Then, after a discussion of cosmological principles, the important stages of development are discussed and the mathematical expressions for each theory are given. The topics discussed include the field equation, relativistic cosmology, Einstein's model, de Sitter's model, Friedman's model, the "steady-state universe," oscillating models of the universe, and some thoughts about singularities in relativistic models of the universe. In conclusion, it is stated that since the substitution of certain empirical data into one of the equations gives satisfactory agreement, the author feels that this offers proof that relativistic cosmology agrees with the actual behavior of the universe and that all three of the Newtonian paradoxes are satisfactorily resolved. (TTT)

20721 THE NATURE OF THE NEUGEBAUER–MARTZ–LEIGHTON OBJECTS. Williams, I. P.; Cremin, A. W. (Univ. of Reading, Eng.). Phys. Lett., 24A: 326-7(Mar. 13, 1967).

It is shown that observed facts about the Neugebauer–Martz–Leighton objects are consistent with a model for pre-main-sequence evolution, but these facts do not imply the correctness of Hoyle's stellar formation model. (auth)

20722 COSMOLOGICAL ELEMENT PRODUCTION. Wagoner, Robert V. (California Inst. of Tech., Pasadena). Science, 155: 1369-76(Mar. 17, 1967).

Two recent observations appear to have provided critical information about the past history of the universe. The thermal character of the microwave background radiation suggests that the universe has expanded from a state of high temperature and density, and places constraints on such a big-bang cosmology. The observations of very weak helium lines in the spectra of certain stars in the halo of our galaxy are possibly due to a low primeval abundance of this element. However, the simplest model of a big-bang cosmology leads to much higher helium abundances, such as are observed in the solar system and in many stars. The production of helium can be reduced either by altering the early expansion rate or by introducing degenerate electron neutrinos. Observations of interstellar and intergalactic deuterium and ^4He, and possibly even ^3He and ^7Li, are needed to test the various models. (auth)

20723 THEORY OF NEUTRON STARS. Gombas, P.; Kisdi, D. (Technical Univ., Budapest. Research Group for Theoretical Physics, Budapest). Z. Naturforsch., 21a: 2009-12(Dec. 1966). (In German).

Using a semi-empirical theory of interaction between neutrons in atomic nuclei, the average energy of a neutron, the equation of state, and the pressure–compressibility relation are computed for a neutron gas of very high density ($n \approx 10^{15}\ g/cm^3$). The results are applied to the computation of the mass and the radius of a neutron star as a function of the central density. For the critical mass, above which a neutron star cannot exist, a value of 0.96 solar masses is found. (auth)

20724 CRITICAL COOKING TIME FOR SUPERHEAVY ELEMENTS BY FAST NEUTRON CAPTURE ACCORDING TO THE SHELL MODEL. Wong, Cheuk-yin. Princeton, N. J., Princeton Univ., 1966. 108p.

Thesis.

On the basis of the assumption that elements close to the neutron drip line are sufficiently stable against spontaneous fission that spontaneous fission can be disregarded in the analysis, the buildup of superheavy elements near the neutron drip line by neutron capture in stellar interiors with a "superflux" of $10^{32}\ n/cm^2$ sec (magnitude of the flux for the r-process of Burbidge, Burbidge, Fowler, and Hoyle) is studied. The energy of the neutrons is taken to be 5 and 100 keV corresponding to a thermal temperature of 4×10^7 and 8×10^8°K, respectively. As the buildup process consists of successive captures of neutrons and intervening beta decays, they are studied with the single-particle model of Nemirovskii. Using this model, the position of the neutron drip line is located. The nuclei under consideration are very neutron-rich and have low neutron binding energies, low excitation energies on neutron capture, and consequently large level spacings. Therefore a direct capture process in which a neutron is captured into a single-particle state with the emission of electric dipole radiation is adopted. As the incident flux consists mainly of s- and p-wave neutrons, the cross section for direct capture into a single-particle state decreases as the angular momentum of the single-particle state increases. For the analysis of beta decay, a purely single-particle model without configuration mixing is adopted. Allowed and first forbidden transition rates are estimated. Under the intense superflux, a superheavy nucleus captures neutrons until no more neutrons can be absorbed, waits for a beta decay, and then captures neutrons again. To have a net increase in the neutron number after a cycle of the capture–decay–capture sequence, two conditions must be satisfied: (1) there are unoccupied neutron single-particle states and (2) the rate of direct radiative capture into these states competes favorably with the rate of beta decay. However, because the orbital angular momentum numbers of the three states just above a magic number of 184 or 258 neutrons are big ($l > 4$), these conditions for a nucleus with a magic neutron number of 184 or 258 are met when its beta decay half life is also relatively long. Thus, the "critical cooking time," which is the time the nucleus spends in the capture–decay–capture cycles before the neutron number increases beyond the magic number is $10^{3\pm2}$ sec for the magic number 184 and $10^{4\pm2}$ sec for the magic number 258. The time scale deduced here is so much bigger than the time scale for the decisive phase of a supernova explosion. Any superheavy nuclei, if observed, must come from other astrophysical phenomena. (Dissertation Abstr.)

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Refer also to abstracts 20946, 21434, and 21568.

20725 (CEA-R-3139) PROPOSITIONS POUR LE MECANISME D'ECHAUFFEMENT D'UN CORPS PAR BOMBARDMENT ELECTONIQUE. (Proposals for the Heating Mechanism of an Electron-Bombarded Body). Geller, Richard; Yerouchalmi, Francoise (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1967. 16p. (In French). Dep. mn.

When a thermally isolated target in vacuum is bombarded by an electron beam the target becomes red. A heuristic explanation indicating how the kinetic power of the beam may be transformed into radiation power controlled by Stefan's law is presented. (tr-auth)

20726 (INR-641/XVIII/PP) FOUNDATIONS OF CLASSICAL THEORY OF ATOM. Gryzinski, Michal (Institute of Nuclear Research, Warsaw (Poland)). July 1965. 63p. Dep. mn.

The recently framed hypothesis that the ground-state electron is subject to radial oscillations in the Coulomb field of the nucleus is expounded. By taking into account the magnetic moment of the electron, the existence of a discrete set of asymptotes of oscillatory motion is revealed. Identification in the isolated nucleus–electron system of the angular momentum taken by a spin–magnetic field with the change of the intrinsic angular momentum of the electron, automatically led on the basis of the conservation laws to the Planck–Bohr quantum postulates, and it appeared that the kinetic energy of translational motion is identical with the kinetic energy in the precessional motion of the electron. From the relations obtained it follows that the radiation process should be associated with the changes in the gyroscopic motion of the particle (precession, mutation) rather than with its acceleration, which should be regarded as a necessary but insufficient condition for the radiation to occur. It has been found that there exists a direct relation between the "de Broglie wave" and the Heisenberg uncertainty principle on the one hand, and the precession motion of the spin axis on the other.

It has also been shown that, for atoms having more than one electron, the energy of spin interaction, on account of the oscillatory character of the motion, plays a decisive role in the formation of electronic shells and the space orientation of the asymptotes in oscillatory motion, a fact which is of primary importance to the explanation of the directional nature of molecular bonds and of the essence of chemical forces, which, in principle, are entirely reducible to electric forces, and may in the first approximation be described through localized charges. On the basis of the results obtained, the conclusion was drawn that wave mechanics may, from the formal point of view, be considered as a special case of classical mechanics operating with relations averaged over some parameters (coordinates). (auth)

20727 (IPP-1/56) SUBSHELL BINDING ENERGIES OF ATOMS AND IONS FROM HYDROGEN TO ZINC. Lotz, Wolfgang (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Feb. 1967. 17p. Dep. mn.

Binding energies of electrons in the K-, L_I-, L_{III}-, M_I-, M_{III}-, M_V-, and N_I subshells of free atoms and of ions of all ionization stages of the elements hydrogen through zinc (Z = 30) are given with full regard to experimental values. (auth)

20728 (LYCEN-6707) ETUDE ET REALISATION D'UNE SOURCE D'IONS LITHIUM, APPLICATION A L'ETUDE DES COLLISIONS ATOMIQUES. (Study and Development of a Lithium Ion Source. Application to the Study of Atomic Collisions). Buchet, Jean-Paul (Lyon Univ. (France). Institute de Physique Nucleaire). Feb. 1967. 73p. (In French). Dep. mn.

Thesis.

After a review of the general results concerning the thermionic emission of solid bodies, the construction of a Li ion source was undertaken as a practical application of the phenomenon. The technical development of the source was made as a function of two specifications: immediate utilization of the ion beam obtained and later mounting of the source on a 4-MeV electrostatic accelerator. Ion intensities above 300 μamp were obtained with a lifetime of the emissive filaments of more than 45 hrs. The ionic intensity is composed of 93% $^7Li^+$ ions and 7% $^6Li^+$ ions. The installation made it possible to measure the ionization and charge exchange cross sections for the collisions between ions and Li and different neutral gases (He_2, N_2, O_2, and CO) with a precision between 10 and 30%. This last study was accompanied by the spectroscopic observation of the luminescence of the gaseous targets. (tr-auth)

20729 (N-67-13122) CORRECTION TO BORN-OPPENHEIMER APPROXIMATION. PART I. Pack, Russell T. (Wisconsin Univ., Madison. Theoretical Chemistry Inst.). Nov. 15, 1966. 88p. (NASA-CR-80492; WIS-TCI-197). CFSTI $3.00 cy, $0.65 mn.

In this study the center-of-mass and rotational motions of an arbitrary diatomic system are exactly separated off. The removal is simplified by the use of the rotation operator itself rather than the representations of the rotation group. The Breit-Pauli Hamiltonian (which allows magnetic and relativistic corrections to be included) is carried through the transformations. Coupled equations for internal motion are obtained which form a basic starting point for any exact treatment of diatomic molecules. Use of angular momentum raising and lowering operators allows the coupled equations to be expressed in a simpler form than they have been previously. The equations are treated by perturbation methods which start from the adiabatic and Born-Oppenheimer approximations. Selection rules and formulas for the corrections to long-range interatomic potentials are given, and significant corrections to the centrifugal potential are found. Finally, the interaction of two hydrogen atoms is treated as an example. (auth)

20730 (NYO-3708-3) A STUDY OF ALPHA PARTICLE REACTIONS IN ATMOSPHERIC GASES. Quarterly Progress Report No. 3, November 16, 1966-February 15, 1967. Fluegge, Robert A. (Cornell Aeronautical Lab., Inc., Buffalo, N. Y.). Feb. 28, 1967. Contract AT(30-1)-3708. 11p. (CAL-VC-2279-P-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Primary events that occur as a result of helium and nitrogen gas bombardment by alpha particles were investigated using an alpha particle mass spectrometer system developed at CAL. (M.H.R.)

20731 (UCRL-14603-T) BINDING IN HELIUM INTERMOLECULAR POTENTIALS. Goldberg, A.; Schey, H. M.; Schwartz, J. L. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 1965. Contract W-7405-eng-48. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method of counting bound states is modified and applied to singular helium intermolecular potentials to determine the conditions under which such potentials support a single bound state. Results are presented for the 6-9 and 6-12 potentials and compared with the results of earlier variational calculations. (auth)

20732 CLASSICAL THEORY OF ELECTRON CAPTURE. Bates, D. R. (Queen's Univ., Belfast); Mapleton, R. A. Proc. Phys. Soc. (London), 90: 909-12(Apr. 1967).

The classical theory of electron capture is adapted for use with the Hartree-Fock-Slater description of the atom (instead of with the Thomas-Fermi description). Calculations are carried out on electron capture by protons from neon and from argon. Good accord is obtained with the experimental data of Stier and Barnett (Phys. Rev., 103: 896-907(1956)), and Barnett and Reynolds (Phys. Rev., 109: 355-9(1958)). (auth)

20733 BINARY-ENCOUNTER PROTON-ATOM COLLISION THEORY. Vriens, L. (Univ., Utrecht). Proc. Phys. Soc. (London), 90: 935-44(Apr. 1967).

Differential and total cross-section formulae in the proton-atom binary-encounter collision model are derived in a very simple way by using the momentum transfer as a variable. By simultaneously using the velocity of the incident particle as a variable, the analogies and differences of the proton-atom and electron-atom binary-encounter collision theories are clearly shown. Possible applications of the theory are discussed, and comparisons with other theoretical models and experimental cross sections are made for the ionization of atomic hydrogen by protons and electrons. (auth)

20734 TRANSFER OF COHERENCE IN ATOMIC COLLISIONS. Series, G. W. (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 90: 1179-80(Apr. 1967).

It is pointed out that a recent observation by Gough on the polarization of sensitized fluorescence constitutes an experimental demonstration of the transfer of coherence from mercury to cadmium atoms in collisions of the second kind. The implications of this are discussed. (auth)

20735 INTERACTION POTENTIAL OF α-PARTICLES OBTAINED FROM SCATTERING DATA AT LOW ENERGIES. Kamuntavicius, G.; Sugurov, V.; Janavicius, A. (Kapsukas State Univ., Vilnyus, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 6: 23-31 (1966). (In Russian).

A theoretical discussion is given for α-particle interaction potentials. Experimental data obtained at low energies are compared with the theory. (M.O.W.)

20736 EXCHANGE INTERACTIONS IN RARE EARTH METALS AND ALLOYS. Vonsovskii, S. V.; Irkhin, Yu. P.; Svirskii, M. S. (Inst. of Metal Physics, Academy of Sciences, SSSR. Chelyabinsk State Pedagogical Inst., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 906-14(June 1966). (In Russian).

The formalism of second quantization is used to discuss the exchange interaction between conduction electrons and the electrons in the f shells of the ions of a rare earth metal lattice, and the exchange interaction between the f electrons to which it gives rise. Additional terms to the s-f exchange Hamiltonian of S. N. Liu (Phys. Rev., 121: 451(1961)) are obtained, which contain operators that change the total angular momentum J of the f-shell electrons by one unit, and the effects of the new terms on magnetic ordering, superconductivity, and phase transitions are discussed. The $J_n \cdot J_m$ terms in the f-f exchange Hamiltonian obtained in the second order of perturbation theory are independent of energy; the s-f exchange associated with change of J, therefore, cannot lead to long-range magnetic order. The new terms in the s-f exchange Hamiltonian lead to interactions between singlet and triplet pairs of conduction electrons. The interaction between singlet pairs is repulsive and results in a reduction of the transition temperature to the superconducting state. The reduction of the transition temperature of La by admixtures of Eu is quantitatively (within 20%) accounted for. The addition of other rare earth metals than Eu, for which $J \neq 0$, only slightly affects the transition temperature. The effect of Eu on the γ-α phase-transition temperature in Ce is also accounted for. A second, more general, exchange Hamiltonian is expressed with the aid of second quantization operators for groups of electrons in a form involving coefficients that can be evaluated in any particular case by use of the appropriate fractional parentage and 6j coefficients. With the aid of this Hamiltonian one can treat anisotropic effects that arise through participation of the orbital angular momentum of the conduction electron, rather than its spin, in the exchange process. (ATD)

20737 SMALL-ANGLE LIMIT FOR TWICE-SCATTERED GAMMA RAYS FROM A POINT-ISOTROPIC SOURCE. Morris, Edgar E.; Spencer, L. V. (National Bureau of Standards, Washington, D. C.). Nucl. Sci. Eng., 27: 485-8(Feb. 1967).

The small-angle limit of the twice-scattered flux from a point

isotropic monoenergetic source of gamma radiation is calculated. Importance is attached to this limit because of a logarithmic divergence of the angular distribution of the twice-scattered flux. Comments intended to facilitate the application to neutrons are given. (M.H.R.)

20738 THE COULOMB WAVE FUNCTION FROM THE VIEWPOINT OF THE LIE ALGEBRA. Chattarji, D. (Visva-Bharati Univ., West Bengal, India). Nuovo Cimento (10), 48A: 524-30(Mar. 21, 1967).

The Laguerre function and the radial Coulomb wave function are defined by their recursion relations. Following a technique introduced by Kaufman, infinitesimal operators which raise and lower indices in these functions are considered as generators of a Lie algebra. An addition theorem for the Laguerre function is rederived using these techniques. The well-known symmetry of the Coulomb problem is explicitly displayed. (auth)

20739 RESONANCE TRANSITION PROBABILITIES IN INTERMEDIATE COUPLING FOR SOME NEUTRAL NONMETALS. Lawrence, G. M. (Princeton Univ., N. J.). Astrophys. J., 148: 261-8(Apr. 1967).

Intermediate coupling calculations are made for the ground configuration and first excited s configuration of neutral Si, Ge, Sn, Pb, P, As, S, Se, Cl, Br, and I. The similar calculations for Si, Ge, Sn, and Pb by Khokhlov are confirmed. Tables of wavelengths, transition probabilities, and spin-orbit parameters are given. Experimental radiative lifetime data are used to provide an absolute scale and thus values of σ^2. Some radiative lifetime measurements by the phase-shift method in GeI, SiI, SnI, ClI, and II are reported. The absolute scale accuracy is ±20%. The relative scale accuracy is thought to be about 10% for strong lines, 31 to 100% for intersystem lines. (auth)

20740 CONTINUOUS ULTRAVIOLET ABSORPTION BY NEUTRAL SILICON. Rich, John C. (Harvard Univ., Cambridge, Mass.). Astrophys. J., 148: 275-81(Apr. 1967).

Photo-ionization cross sections (bound-free absorption coefficients) for the $3s^2\ 3p^2\ ^3P$ ground state and ^1D excited level of the neutral silicon atom were measured by means of conventional shock-tube techniques. The measurements give cross sections of about 37 and 33 megabarns (10^{-18} cm^2), respectively, near the ionization limits, and these values compare favorably with recent theoretical calculations. The next excited ^1S level of this configuration is briefly discussed. (auth)

20741 INFLUENCE OF NUCLEAR DYNAMICS ON THE X-RAY SPECTRUM OF MUONIC ATOMS. Pieper, W.; Greiner, W. (Univ., Frankfurt am Main). Phys. Lett., Part B, 24: 377-80 (Apr. 17, 1967).

Energies and intensities of the muonic transitions 4f → 3d → 2p → 1s are calculated for heavy deformed nuclei. Rotations, surface vibrations, giant resonance oscillations and vacuum polarization effects are included. The energy shifts of nuclear 2^+ levels in presence of the muon are of the order, 0.9 to 0.5 keV. Good agreement with experimental muonic transition is obtained by fitting the nuclear radius and the nuclear deformation. The surface thickness is obtained from the zero-point fluctuations of the surface motion (rotations and vibrations). The excitation of the nuclear β and γ vibrations by the meson turns out to be very small. The nuclear polarization shifts due to the virtual giant multipole resonance excitation are calculated for the 1s, 2p, and 3d states of the meson. (auth)

20742 MEASUREMENT OF K^--MESONIC X RAYS FROM Li, Be, B, AND C. Wiegand, Clyde E.; Mack, Dick A. (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 685-8(Apr. 24, 1967).

K^--mesic x-ray lines emitted by the elements ^{7}Li, ^{9}Be, ^{nat}B, and ^{12}C are reported. A data comparison is made with earlier reported data. (M.O.W.)

20743 ELECTRON BEAM FOCUSING BY A PERIODIC MAGNETIC FIELD AND BY AN ADDITIONAL ELECTRIC FIELD. Kormilitsin, B. T. Radiotekh. Elektron., 11: 1777-80(Oct. 1966). (In Russian).

The additional electric field necessary to produce a sharp cylindrical beam in a periodic magnetic field was computed. (tr-auth)

20744 OBTAINMENT OF ELECTRON CURRENT FROM ARC-DISCHARGE PLASMA IN METAL VAPORS. Neretina, N. A.; Timofeeva, G. G. (Lenin All-Union Electrotechnical Inst., Moscow). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 106-7(1966). (In Russian).

Experiments were carried out to determine the feasibility of using arc-discharge plasmas in metal vapors as a strong electron source. Copper, tin, and mercury cathodes were used, collecting the electrons which penetrated into the anode space by means of an accelerating electrode. By judicious choice of the vapor pressure in the space where the electrons were accelerated, the positive ions formed by the ionization of the gas prevented a discharge between the plasma cathode and the accelerating electrode. A low-potential arc was generated between the stainless steel anode and the copper or tin cathode. With solid electrodes, 20 mamp was obtained with copper and 6.5 mamp with tin at discharge currents of 50 and 30 amp and accelerating potentials of 0.9 and 0.45 kV, respectively. For mercury, a special discharge tube was designed; it yielded an electron current of 1.5 amp at a discharge current of 25 amp and an accelerating potential of 5 kV. This was arrived at by using an arc anode orifice of 40 mm; enlargement of the area resulted in a corresponding amplification of the electron current. (TTT)

20745 IMAGE METHOD IN ELECTRODYNAMICS OF CONTINUUM MEDIA. Pafomov, V. E. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 240-53(1967). (In Russian).

A method is proposed to find the electromagnetic field of an arbitrarily moving charged particle in the presence of plane interfaces of media. The method is based on the possibility of representation of the particle field as that of a set of fixed dipoles situated on the trajectory of the particle. Instead of interfaces one may introduce the image dipoles and, by means of the reciprocity theorem, find the parameters of the above dipoles when requiring the identity of fields in the presence of the moving charge and interfaces and with the same charge and its images (equivalent to the sets of image dipoles) without interfaces. According to the principle of radiated charge motion, the spectral expansion of the radiation field was found in the case of one and two interfaces of isotropic media with different permeabilities and permittivities. (auth)

20746 METHODS FOR DETERMINING POTENTIALS OF ATOM, MOLECULE, AND ION INTERACTIONS. Leonas, V. B.; Samuilov, E. V. (Power Engineering Inst., Moscow). Teplofiz. Vysok. Temp., 4: 710-24(Sept.-Oct. 1966). (In Russian).

Basic theoretical and experimental methods for determining the interaction potentials of molecules, atoms, and ions are described. A list of potentials with tabulated magnitudes of the second virial coefficient, B^*, and interaction integrals, $\Omega^{(l,s)*}$, is included. (tr-auth)

20747 COMPLETE CLASSIFICATION OF THE STATES OF THREE-ELECTRON ATOMS. Delves, L. M. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 46: 2563-71(Apr. 1, 1967). (ORNL-P-2481).

A complete, finite expansion is given for an arbitrary state of a three-electron atom. This expansion separates the simple dependence of the wave function on the spin and Euler-angle variables from the complicated and in general unknown dependence on the relative positions of the particles. (auth)

20748 ATOMIC SCATTERING FACTORS FOR ELECTRONS AS CALCULATED BY THE PARTIAL-WAVES METHOD. Kimura, Masao; Konaka, Shigehiro; Ogasawara, Makoto (Hokkaido Univ., Sapporo). J. Chem. Phys., 46: 2599-2603(Apr. 1, 1967).

Complex atomic scattering factors were calculated from the partial-wave scattering theory using the Hartree–Fock atomic potentials for the atoms H to Kr and the Thomas–Fermi–Dirac atomic potential for the atoms Kr to Cm. The partial phase shifts were approximated in terms of modified Bessel functions of the second kind. (auth)

20749 MOLECULAR COLLISIONS. V. NEARLY SPHERICAL POTENTIALS. Curtiss, C. F.; Hardisson, A. (Univ. of Wisconsin, Madison). J. Chem. Phys., 46: 2618-33(Apr. 1, 1967).

Expressions are developed for the coefficients in spherical harmonic expansions of the degeneracy-averaged cross sections for collisions between rigid diatomic molecules that interact through a soft nearly spherical potential. The development is based on a perturbation method that is essentially an extended distorted-wave treatment. Explicit expressions for the moments of the cross sections to second order in the perturbation parameter are obtained in a form suitable for numerical evaluation and application to the kinetic-theory evaluation of the transport coefficients. The expressions are simplified through the use of an expression developed for a sum of products of 12-j symbols. (auth)

20750 ENERGETIC IONS FROM N_2 PRODUCED BY ELECTRON IMPACT. Kieffer, L. J.; Van Brunt, R. J. (Univ. of Colorado, Boulder). J. Chem. Phys., 46: 2728-34(Apr. 1, 1967).

Energy distributions, appearance potentials, and angular distributions of N^+ ions produced by electron impact on N_2 have been observed. The energy distribution and appearance potential of the N^{++} ions from electron impact on N_2 were also observed. The data

are interpreted to give the abundance of the zero-energy N^+ and the N^{++} ions. The appearance-potential data for the zero-energy N^+ ions disagree with previous measurements, and a possible interpretation indicates that the conclusion of previous investigators that no excited ions are produced may not be valid. (auth)

20751 THERMAL-ENERGY ION–NEUTRAL REACTION RATES. VII. SOME HYDROGEN-ATOM ABSTRACTION REACTIONS. Fehsenfeld, F. C.; Schmeltekopf, A. L.; Ferguson, E. E. (Environmental Science Services Administration, Boulder, Colo.). J. Chem. Phys., 46: 2802-8(Apr. 1, 1967).

Rate constants for reactions in which the positive ions O^+, N^+, Ar^+, N_2^+, CO^+, CO_2^+, and N_2O^+ abstract a hydrogen atom from H_2 have been measured at 300°K in a pulsed, flowing-afterglow reaction tube. Several additional reactions are observed, which occur as secondary reactions in these experiments. (auth)

20752 QUENCHING OF GLORY UNDULATIONS IN SCATTERING OF SODIUM ATOMS FROM POLYHALIDE MOLECULES. Gislason, E. A.; Kwei, G. H. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 46: 2838-40(Apr. 1, 1967).

The velocity dependence of total cross sections has been measured for the scattering of Na atoms from CBr_4, Br_2, $SnCl_4$, CCl_4, CH_3I, SF_6, and $SiCl_4$ (listed in order of decreasing chemical reactivity). All these systems show the $v^{-4/5}$ velocity dependence expected for the long-range r^{-6} dispersion force term in the intermolecular potential. However, the usual undulatory structure from "glory scattering" associated with the van der Waals potential well appears in only one case, Na + SF_6. For the most reactive systems, Na + CBr_4, Br_2, $SnCl_4$, this absence of undulations may be attributed to quenching by reactive scattering, which is important even at impact parameters outside the van der Waals radius. For CH_3I, the quenching is probably due to the anisotropy of the intermolecular potential. For CCl_4 and $SiCl_4$, it seems plausible that the quenching may be due to the presence of low-frequency vibrations, which distort the molecule appreciably during the collision. (auth)

20753 CROSSED-BEAM STUDY OF A SIMPLE ION–MOLECULE REACTION IN THE ENERGY RANGE 0.70 TO 25 eV. Herman, Z.; Kerstetter, J. D.; Rose, T. L.; Wolfgang, Richard (Yale Univ., New Haven). J. Chem. Phys., 46: 2844-5(Apr. 1, 1967).

In a crossed-beam study of the ion–molecule reaction $N_2^+ + D_2 \rightarrow N_2D^+ + D$, angular distributions and the energies of the charged species were measured. The results show that in every case substantially all the N_2D^+ recoils forward in the center-of-mass system. This suggests that the collision complex has a lifetime of less than one rotation and that the reaction proceeds by a direct or impact mechanism. At 25 eV a spectator stripping model proposed by Henglein appears to be a reasonable approximation of the system, but at lower energies increasing deviations appear. At lower energies the results are consistent with a modified stripping mechanism. (A.G.W.)

20754 EFFECTIVE ROTATIONAL TEMPERATURES OF N_2^+ (3914 A) EXCITED BY MONOENERGETIC ELECTRONS IN A CROSSED BEAM. Culp, G.; Stair, A. T. Jr. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Chim. Phys., 64: 57-62(Jan. 1967).

The effective rotational temperature of N_2^+ has been determined as a function of electron energy for energies from 19 to 300 eV. Temperatures were obtained by analysis of relative line intensities in the R branch of the resolved 3 914 Å band spectrum. Pure N_2 gas in a collimated beam was crossed with a nearly monoenergetic electron beam and the 3 914 Å excitation recorded photoelectrically; excitation was by single electron impact. Measurements show reasonable agreement between observed rotational temperature and the gas temperature for energies from 100 to 300 eV. The rotational temperature was observed to depend upon electron energy for energies below 100 eV; the dependence is nonmonotonic with an apparent maximum near 50 eV, followed by a minimum near 25 eV. The temperature reaches a maximum of about 350°K at 19 eV (threshold energy 18.7 eV) for a gas temperature of 296°K. Observed rotational energies of N_2^+ followed a Boltzmann distribution except for an apparent slight enhancement in population for those energy levels corresponding to the lowest several rotational quantum numbers. (auth)

20755 OPTICAL EMISSIONS OF OXYGEN, NITROGEN, AND NITROGEN–OXYGEN MIXTURES STIMULATED BY 20- TO 100-keV PROTONS. Baker, Doran J.; Gardiner, H. A. B.; Merrill, J. J. (Utah State Univ., Logan). J. Chim. Phys., 64: 63-70 (Jan. 1967).

The excitation of oxygen, nitrogen, and their atmospheric mixture by impact of 20- to 100-keV protons was studied at gas pressures from 1 to 100 mtorr. Radiation emitted from excited structures was spectrally analyzed to obtain absolute emission cross sections for dominant features in the spectral interval 3400 to 5700 Å. The spectra from protons on nitrogen showed the N_2^+ first negative and the N_2 second positive band systems, plus multiplets from N, N^+, and N^{++}. O^+ multiplets and the O_2^+ first and second negative systems were predominant in the protons on oxygen spectra, although a few O and O^{++} lines were also present. The emission cross sections for the atomic lines maximized at about 40 keV, whereas the band emissions increased as the energy of the incident protons decreased over the energy range studied. Absolute cross sections are given for selected bands and lines. (auth)

20756 METHODS FOR THEORETICAL STUDY OF VIBRATIONAL STATES WITH LARGE AMPLITUDE OF OSCILLATION AND SELECTION RULES FOR CERTAIN NONRADIATIVE CONVERSIONS. Teissier du Cros, Francois; Gouyet, Jean-Francois (Ecole Polytechnique, Paris). J. Chim. Phys., 64: 147-54(Jan. 1967). (In French).

When, in a molecule, large oscillations of the nuclear skeleton occur, the separation of the motion of the electrons from nuclei is no longer a good approximation. It is assumed that the skeleton and the electronic cloud give an average potential, invariant by the symmetry group G. A vibrational state is then characterized by the energy E, the irreducible representation D^{μ} of G, and the spin multiplicity S to which it belongs. A method of construction by means of single electron molecular orbital configurations is provided. An example is given: the first levels of the linear acetylene molecule. However, the vibrations are not taken into account. (auth)

20757 PROBABILITY OF RECOILLESS EMISSION AND ABSORPTION OF NUCLEAR GAMMA RADIATION. Bara, Jozef (Jagellonian Univ., Krakow). Postepy Fiz., 18: 13-27(1967). (In Polish).

Research on the probability of recoilless emission and absorption of nuclear gamma radiation provides some information on the microdynamics of the crystal lattice. The dynamic properties of a crystal lattice in harmonic approximation and methods of calculating and measuring the probability of recoilless emission and absorption of nuclear gamma radiation are discussed. (auth)

20758 ELECTRON DIFFRACTION FROM PERIODIC MAGNETIC FIELDS. Goringe, M. J.; Jakubovics, J. P. (Cambridge Univ., Eng.). Phil. Mag., 15: 393-403(Feb. 1967).

Nonuniform magnetic fields act as diffraction apertures on electron beams crossing them, owing to the phase changes introduced. It is shown that periodic fields act as phase gratings, producing a pattern of regularly spaced spots which can be observed in the electron microscope, using low-angle diffraction techniques in certain cases of practical interest. In many instances the variation of phase can be adequately described by a series of linear functions. Formulae for the observed intensity are derived for such cases. It is found that: (i) In the case of periodic magnetic domain structures, the calculated results are in good agreement with observations. (ii) In the case of antiferromagnetic lattices, the results show that the diffracted intensities are probably too weak to be observed. (iii) In principle it should be possible to observe diffraction effects in a type-II superconductor containing a periodic array of flux lines. (auth)

20759 LAWS GOVERNING CROSS SECTIONS FOR ELECTRON-IMPACT EXCITATION OF LOWER LEVELS OF HELIUM. Zapesochnyi, I. P. (Uzhgorod State Univ., USSR). Dokl. Akad. Nauk SSSR, 171: 559-61(Nov. 21, 1966). (In Russian).

In view of the lack of data on the absolute excitation cross sections of the most significant helium energy levels, some results of systematic investigations on the excitation of helium atoms by collision with slow electrons are presented. Direct measurements were made of the excitation cross sections of 32 lines in the spectral interval 2900 to 11000 Å and in the electron energy range 150 to 250 eV. The absolute cross sections were then determined for between 4 and 7 of the lower S, P, and D levels of para- and orthohelium, using a formula deduced for this purpose and data on the polarization of the spectral lines of the helium. The results are summarized in a table. They show that the energy dependence of most levels is characterized by two maxima, and that the excitation cross sections exhibit a regular behavior that can be expressed by the formula $Q_k(E) = Cn^{-\alpha}$, where Q is the excitation cross section, E the energy, n the principal quantum number of the level, C a constant, and α an integer exponent. (ATD)

20760 A QUARK ALBEDO? McDowell, M. R. C. (Univ. of Durham, Eng.); Hasted, J. B. Nature, 214: 235-7(Apr. 15, 1967).

A mechanism is proposed by which quarks could become bound to atomic systems of relatively low molecular weight such as oxygen or water. They may then undergo a cyclic process of

reflexion from the Earth's surface, reaching heights of 50 km or more. It is proposed that such quarks could be detected by sampling the upper atmosphere from rockets or by taking samples from the ocean floor of the continental shelf. (UK)

20761 PHONON EFFECTS IN THE MOTION OF POSITRONS IN METALS. Mikeska, H. J. (Technische Hochschule, Munich). Phys. Lett., 24A: 402-4(Apr. 10, 1967).

The positron–phonon interaction is shown to lead to an important tail in the positron momentum distribution. The tail can account for at least part of the large so-called effective mass of positrons in sodium. (auth)

20762 DOUBLE IONIZATION OF He. Van der Wiel, M. J.; De Heer, F. J.; Wiebes, G. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam). Phys. Lett., 24A: 423-4 (Apr. 10, 1967).

Two-electron transitions in He produced by electron and proton impact are considered. The calculated (1/E)ln E term in the cross section is compared with experiment. The importance of a calculation of the (1/E) term is shown. (auth)

20763 POSSIBILITY OF OBSERVING MANY-BODY EFFECTS IN ATOMIC ELECTRON SHELLS. Amusya, M. Ya.; Afrosimov, V. V.; Gordeev, Yu. S.; Cherepkov, N. A.; Sheftel, S. I. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 24A: 394-6(Mar. 27, 1967).

The analysis of inelastic scattering of keV electrons by atoms as a function of the energy transferred in collision is proposed to reveal the role of many-body effects in an atom. (auth)

20764 INFLUENCE OF THE SCATTERING MATERIAL DENSITY ON QUANTUM BACKSCATTERING. Koch, S. (Technical Univ., Dresden). Isotopenpraxis, 3: 11-14(Jan. 1967). (In German).

The influence of the scattering material density on backscattering rate is dependent on quantum energy, geometry of the measurement, and atomic number of the substance to be investigated. The backscattering rate attains a maximum value at a distinct density if the detector is hit preferentially by quanta having passed through a long distance within the scatterer. For small pathways of the quanta within the scatterer, the backscattering rate increases with density and approaches a saturation value which may already be attained practically within the measuring range. (auth)

20765 OPTICS OF HIGH-EFFICIENCY ELECTRON GUNS. Kawakatsu, H.; Matsui, S.; Kanaya, K. (Electrotechnical Lab., Tokyo). Optik, 22: 476-90(1965).

The focusing properties of electron guns may be revealed by the observation of caustic and shadow images and their theoretical evaluation. In the ordinary three-electrode gun, the focusing action is regarded as that of a lens with spherical and astigmatic aberrations, and the current density in the beam is limited by the large spherical aberration. At the same time, the high-working current in the four-electrode gun can be explained by the decrease of third-order spherical aberration and the effective addition of the fifth-order one. (auth)

20766 ACTUAL PROBLEM OF SECONDARY ELECTRON EMISSION. Seiler, H. (Univ., Tuebingen, Ger.). Z. Angew. Phys., 22: 249-63(1967). (In German).

Recent experimental work concerned with three particular aspects of secondary electron emission is surveyed: 1. The pathlength of the secondary electrons inside the target: The maximum exit depth T and the mean free pathlength λ, which are measured or calculated by different methods, are compared. It is shown that $T = 5\lambda$; for metals $T \approx 50$ Å and $\lambda \approx 10$ Å, and for insulators, both are approximately ten times larger. 2. The contribution of the backscattered electrons to the emission of the secondary electrons: The fraction of slow secondary electrons emitted by backscattered electrons increases with backscattering coefficient η from about 0.25 at $\eta = 0.05$ to 0.7 at $\eta = 0.45$. Backscattered electrons generate some 4 to 6 times more secondary electrons, on the average, than do primaries. The number of the secondary electrons which are released in the maximum of the yield only by the primaries decreases with increasing radius AR of the target atoms from 1 at AR = 0.77 Å to 0.17 at AR = 2.7 Å. 3. Field-enhanced secondary electron emission: This can be observed on both porous and dense thin insulating films with stable electron gains up to $\delta = 70$. This effect is often explained in terms of a Townsend-avalanche in porous layers, but it is shown here that δ also increases with the maximum exit depth T caused by the electric field. Low field enhancement factors $\lesssim 4$ can be explained on the basis of electron drift in the target. (auth)

20767 DETERMINATION OF K-SHELL PHOTOELECTRIC CROSS-SECTIONS. Ghumman, B. S.; Anand, S.; Sood, B. S. (Punjabi Univ., Patiala, India). Indian J. Pure Appl. Phys., 5: 70-2(Feb. 1967).

The method of determination of the photoelectric cross section of gamma rays from measured intensities of K-shell fluorescent radiation that follow the interaction reported by Oberoi [Oberoi et al., Curr. Sci., 34: 372(1965)] was employed for determining the K-shell photoelectric cross sections of 280- and 662-keV gamma rays in lead, gold, tungsten, and tin. This method is simpler compared to the existing methods and has a wider applicability, although its accuracy is limited by the uncertainties in the various corrections that have to be applied to determine the absolute yield of K-shell x rays. The experimental values of the cross sections are found to agree well with those predicted by theory. (auth)

20768 NEW QUADRUPOLE LINES IN THE L EMISSION SPECTRUM OF PRASEODYMIUM. Shukla, S. N.; Singhal, R. P. (Lucknow Univ., India). Proc. Phys. Soc., (London), 90: 859-62 (Mar. 1967).

The L emission spectrum of praseodymium has been investigated using a 40-cm curved mica crystal spectrograph. Three new diagram lines at 1841.5, 1922.2, and 2076.1 x.u., corresponding to the quadrupole transitions $L_I N_{IV,V}$, $L_{II} N_{VI,VII}$ (γ_5), and $L_{III} N_{VI,VII}$ (β_7) respectively, have been observed for the first time. The data on the measurement of other L series lines of praseodymium have also been studied, with a view to removing the discrepancies in the earlier measurements. (auth)

20769 STRUCTURE OF THE ARGON K SERIES IN THE ATOMIC CAPTURE OF NEGATIVE MUONS IN A PURE GAS AND IN A MIXTURE WITH HYDROGEN. Budyashov, Yu. G.; Ermolov, P. F.; Zinov, V. G.; Konin, A. D.; Mukhin, A. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 599-602 (Mar. 1967). (In Russian).

It was observed that the intensity in the K series of Ar is considerably higher if a negative muon is transferred from a $p\mu$ atom to Ar, than in the direct capture of the muon by Ar. (auth)

20770 INVESTIGATION OF THE STRUCTURE OF THE K SERIES IN THE ATOMIC CAPTURE OF NEGATIVE MUONS IN CHEMICAL COMPOUNDS. Zinov, V. G.; Konin, A. D.; Mukhin, A. I.; Polyakova, R. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 591-8(Mar. 1967). (In Russian).

The structure of the muonic x-ray K series was investigated in the atomic capture of negative muons by Ti, V, Cr, and their oxides. A significant difference was observed between the yield of various K lines in a pure element and in its oxide. (auth)

20771 MEASUREMENT OF THE VELOCITY DEPENDENCE OF THE TOTAL CROSS SECTIONS FOR ATOM–ATOM COLLISIONS IN THE ENERGY REGION BETWEEN 6 AND 1000 eV. Hollstein, M.; Pauly, H. (Univ., Bonn). Z. Phys., 201: 10-19 (1967). (In German).

The velocity dependence of the total scattering cross section Q(v) for fast Cs, K, and Na beams scattered by Xe, Kr, and Ar was measured for energies of 6 to 1000 eV. In all cases, the transition region between the $v^{-\frac{1}{3}}$ dependence of Q(v) (where the cross section is predominantly influenced by the attractive part of the potential) and the high energy behavior (where the cross section is determined by the repulsive part of the potential) is observed. Values for the product ϵr_m of the potential well depth ϵ and the equilibrium distance r_m are determined by comparing the measurements with calculations for a five parameter potential model. (auth)

20772 TRANSITION RADIATION AT TWO PARALLEL SEPARATING BOUNDARIES. Pafomov, V. E.; Frank, I. M. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 5: 631-40 (Mar. 1967). (In Russian).

The problem is solved on the radiation of a charged particle penetrating three media separated by flat boundaries. The influence of thin surface films on the transition radiation is considered, as well as the radiation in case of a pile of transparent plates. (auth)

20773 RADIATIVE LIFETIMES OF SOME n equals 4 AND n equals 5 STATES IN He II. Jordan, J. A. Jr.; Bakken, G. S.; Yager, R. E. (Rice Univ., Houston). J. Opt. Soc. Amer., 57: 530-4(Apr. 1967). (ORO-1316-16).

The radiative lifetimes of the 4S, 4D, 4F, 5S, 5P, 5D, and 5F states were measured in singly ionized helium using the high-energy atomic-beam technique. The measured values of the lifetimes are in excellent agreement with those calculated for hydrogenic atoms. Extensions of the experimental technique to the measurement of excitation cross sections and fine-structure splittings are discussed. (auth)

20774 GROUND-STATE HYPERFINE SPLITTING OF SINGLY CHARGED ^{3}He. Goldwire, H. C. Jr. (Rice Univ., Houston, Tex.). Phys. Rev. Lett., 18: 433-4(Mar. 20, 1967).

Although the theoretical and measured values of the ratio of the hyperfine energy splitting of the 2S state to that of the ground state (1S) agree within experimental error for both H and D, a recently reported high-precision measurement of the ground-state hfs of singly charged ^{3}He has been interpreted to lead to a small but definite disagreement with the theoretically predicted ratio of the 2S-to-1S hfs (Phys. Rev. Lett., 16: 221(1966)). It is shown that correction of an error in the calculation of the above reference of the theoretical value of this ratio leads in fact to excellent agreement of the measured and the theoretical values. (W.D.M.)

20775 RADIATIONAL POLARIZATION OF ELECTRONS IN INHOMOGENEOUS MAGNETIC FIELD. Baier, V. N.; Katkov, V. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett., 24A: 327-9(Mar. 13, 1967).

The process of polarization of electrons due to radiation in an inhomogeneous magnetic field has been considered by means of operator formulation of a quasiclassical approximation. A general expression for the probability of a spin-flip radiational transition in an arbitrary magnetic field has been obtained. (auth)

20776 FIRST-ORDER IMPACT PARAMETER TREATMENT OF THE EXCITATION OF HELIUM BY PROTONS. Van Den Bos, J. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam). Phys. Lett., 24A: 329-30(Mar. 13, 1967).

A formula is presented by which analytical expressions can be derived for the cross section of excitation of n-electron atoms by protons, neglecting the correlation of electrons. The procedure is applied to the excitation of helium from the ground state to $(1s,3p)^1P$ and $(1s,3d)^1D$. (auth)

20777 ION MOTION UNDER THE INFLUENCE OF CHARGE-EXCHANGE COLLISIONS. Fahr, Hansjoerg; Mueller, Karl Gerhard (Univ., Bonn). Z. Phys., 200: 343-65(Mar. 14, 1967). (In German).

The motion of ions under the influence of an electric field and a density gradient is investigated by taking into account only charge-transfer collisions between the ions and a neutral gas background. The two model cases of constant mean free path and constant mean free time are considered. For weak electric fields the Boltzmann equation can be solved using a special expansion of the velocity distribution. The expansion in Sonine polynomials as given by Chapman and Cowling does not converge. For medium and high electric fields the velocity distribution is calculated by collecting the contributions of the different paths of the ions. The inhomogeneous drift in high electric fields is investigated for a small perturbation by gradients of the electric field, the ion density, and of the mean free path. (auth)

20778 TIME-DEPENDENT HARTREE–FOCK THEORY AND LONG-RANGE INTERACTIONS. Dalgarno, A.; Victor, G. A. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 90: 605-8 (Mar. 1967).

It is shown that time-dependent Hartree–Fock theory can be used to calculate the interaction potential of atomic systems at large separations. Explicit calculations are performed for a pair of helium atoms. Comparison of the result with other data suggests that the calculated coefficients are too small by about 7% and the interaction potential (in atomic units) is more accurately represented by $V(R) = -\{1{\cdot}47/R^6 + 14{\cdot}1/R^8 + 182/R^{10} + O(1/R^{11})\}$. Calculations of the nonadditive long-range interaction potential for three helium atoms are also reported. (auth)

20779 HIGH PRECISION MEASUREMENTS OF THE g_J-FACTORS OF THE ALKALIS USING THE ATOMIC BEAM MAGNETIC RESONANCE METHOD. Boeklen, K. D. (Univ., Heidelberg); Dankwort, W.; Pitz, E.; Penselin, S. Z. Phys., 200: 467-86(1967).

The g_J-factors of ^{6}Li, ^{7}Li, ^{23}Na, ^{85}Rb, ^{87}Rb, and ^{133}Cs in their $^2S_{\frac{1}{2}}$ ground states were measured relative to the g_J factor of ^{39}K with a precision of a few parts in 10^7 using the atomic beam magnetic resonance method. (auth)

20780 INFLUENCE OF THE SURFACE SCATTERING OF ELECTRONS ON THE METALLIC FIELD EFFECT IN THIN LAYERS. Juretschke, H. J. (Polytechnic Inst. of Brooklyn). Surface Sci., 5: 111-19(Sept. 1966).

Previously proposed models for mean-free-path influences on the change of conductance of a metallic film due to electrostatic charging were evaluated using the alternate description of electron scattering by a surface recently introduced by Parrott, Cotti, and others. If fully specular and fully diffuse scattering occurs in two complementary ranges of the angle of incidence of an electron, the field effect shows a saturation in the thin-film limit similar to that of the conductivity. The contributions to the conductance arising from field-induced changes in cutoff angle for specular scattering, in surface charge density, or in film thickness, show distinct size effects, which differ from the corresponding effects calculated according to the Fuchs–Sondheimer model. The range of magnitudes and the temperature dependence of the 3 contributions relative to that of the thin film resistivity are discussed. (BBB)

20781 STUDY OF THE EXCITATION OF NITROGEN AND OXYGEN BY PROTON COLLISIONS. Dufay, Maurice; Desesquelles, Jean; Druetta, Michel; Eidelsberg, Michele (Faculte des Sciences, Lyon). Ann. Geophys., 22: 614-27(Oct.-Dec. 1966). (In French).

The excitation of nitrogen and oxygen by protons in the energy range 20 to 600 keV was studied. Emission cross sections of radiations due to primary collisions were measured under the thin-target conditions: with nitrogen, those of N_2^+ ($B^2\Sigma \rightarrow X^2\Sigma$) and ($A^2\pi \rightarrow X^2\Sigma$) band systems and those of greatest transitions of N I and N II; with oxygen, those of O_2^+ ($b^4\Sigma \rightarrow a^4\pi$) and ($^2\pi \rightarrow {}^2\pi$) band systems and those of O I and O II lines. The vibrational structure of band systems observed (N_2^+ first negative system, N_2 first and second positive systems, O_2^+ first and second negative systems) was analyzed and shown to correspond to high vibrational temperatures. The vibrational structure seemed not to change with incident proton energy. The relative transition probabilities were deduced from the measured intensities in the following cases: N_2^+ first negative system, N_2 second positive system, and O_2^+ first negative system. By means of a charge collector with parallel plates, total ionization cross sections and charge exchange cross sections for N_2 and O_2 were also measured in the same energy range. (BBB)

20782 DECELERATION SPECTRUM OF LIGHT PARTICLES IN HEAVY GAS, WITH A CONSIDERATION OF THE CAPTURE PROCESS. Arifov, P. U.; Gol'danskii, V. I.; Sayasov, Yu. S. (Physical-Technical Inst., Tashkent. Inst. of Chemical Physics, Moscow). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 5, 48-53(1966). (In Russian).

A general study is made of the slowing-down process of electrons and positrons in a stationary cloud of atoms and positive ions. An equation for zero loss processes and an equation including loss processes are given for the stationary distribution of light particles in a heavy gas in the absence of an electric field. For a weak electric field a first-order correction to the stationary solution, corresponding to elastic–inelastic momentum-transfer processes is calculated. Some numerical results are given in tabular form to compare the various distribution functions derived. (TSS)

20783 PHOTOABSORPTION STUDIES OF DISCHARGED HYDROGEN. Cairna, R. B.; Samson, J. A. R. (GCA Corp., Bedford, Mass.). Proc. Phys. Soc. (London), 90: 879-81(Mar. 1967).

Studies have been made of the absorption of photons (λ between 1000 and 800 Å) by the gas flowing from a hydrogen discharge. Metastable species have been detected in the gas in addition to ground-state molecular and atomic hydrogen. The effects of these metastable particles on previously reported measurements of the photoionization cross section of atomic hydrogen are discussed. (auth)

20784 THE GROUND STATE OF H_2^-. Taylor, H. S. (Univ., [Bonn]). Proc. Phys. Soc. (London), 90: 877-9(Mar. 1967).

Somerville [Proc. Phys. Soc. 89: 185(1966)] has stated that from the adiabatic calculation of Taylor and Harris [J. Chem. Phys., 39: 1012(1963)] the existence of a bound state of H_2^- with very small binding energy cannot be ruled out, from a mathematical point of view. From both theoretical and experimental work on H_2^- since 1964, additional physical arguments are available to show that a nonadiabatic study is very unlikely to change the conclusion of the adiabatic work that a bound state of H_2^- does not exist. (auth)

20785 IONIZATION PROCESSES IN HELIUM AT PRESSURES NEAR TO ATMOSPHERIC. Dutton, J.; Rees, D. B. (University Coll. of Swansea, England). Brit. J. Appl. Phys., 18: 309-15 (Mar. 1967).

Determinations of primary α and secondary ω ionization coefficients in helium at pressures p_0 near to atmospheric and low values of E/p_0 (E is the electric field) show that $\alpha/p_0 = f(E/p_0$ and $\omega/\alpha = \phi(E/p_0)$ for $30 < p_0d < 730$ cm torr. The results obtained for ω/α and its dependence on E/p_0 are shown to be adequately accounted for on the basis of the assumption that the predominant secondary ionization process in helium at high pressures is the destruction of metastable states in the gas with the consequent production of nonresonance photons, which liberate secondary electrons at the cathode. (auth)

20786 MOLECULAR MOTIONS IN LIQUID AND SOLID HYDROGEN AND DEUTERIUM. Egelstaff, P. A.; Haywood,

B. C.; Webb, F. J. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 90: 681-96(Mar. 1967).

Molecular motions in liquid and solid hydrogen and deuterium have been investigated by the inelastic scattering of cold neutrons. In all cases discrete peaks are observed corresponding to $\Delta J = 0$ and $J = 1 \rightarrow 0$ rotational transitions. In solid hydrogen there is no broadening of the elastic peak ($J = 1 \rightarrow 1$), but the inelastic peak ($J = 1 \rightarrow 0$) is appreciably broader than the experimental resolution. The peak widths are in fair agreement with the theoretical predictions of Elliott and Hartmann [Proc. Phys. Soc. 90: 671-80(1967)], confirming that quadrupole–quadrupole interactions are dominant. In liquid hydrogen both elastic and inelastic peaks are broadened by diffusive motion of the molecules, consistent with macroscopic measurements of the diffusion coefficient. In both solid and liquid hydrogen, scattering by intermolecular vibrations is observed; the liquid hydrogen results are fitted approximately by a simple model containing one arbitrary parameter. Measurements on solid and liquid deuterium show the same qualitative features of rotational and diffusive motions, but are complicated by the appearance of peaks due to coherent scattering. (auth)

20787 DRIFT VELOCITIES OF ELECTRONS IN NITROGEN AND HYDROGEN. Prasad, A. N.; Smeaton, G. P. (Univ. of Liverpool). Brit. J. Appl. Phys., 18: 371-3(Mar. 1967).

Electron drift velocities have been measured in nitrogen and hydrogen over the E/p range 4 to 40 V cm^{-1} $torr^{-1}$ using a drift tube apparatus incorporating fast shutters. A brief description of the apparatus and technique is included. (auth)

20788 ON PHYSICAL INTERPRETATION OF SOLUTIONS OF THE EINSTEIN EQUATIONS. Keres, Kh. (Inst. of Physics and Astronomy, Tartu). Zh. Eksp. Teor. Fiz., 52: 768-79(Mar. 1967). (In Russian).

A general method based on the correspondence principle is proposed for physical interpretation of solutions of the Einstein equations. The method yields information on the solution with an accuracy to relativistic effects. In particular, the distribution of sources of the gravitational field described as the solution of the Einstein equations for empty space can be determined. As an example the Kerr solution is considered. It is shown that the corresponding gravitational field is generated by a nonhomogeneous circular disk of negative mass distribution whose density is given. A material curve of positive infinite linear density is situated on the edge of the disk. Rotation of local inertial systems is investigated. An asymptotic method for studying the local properties of a strong gravitational field is proposed. As an example the method is applied to the problem of motion of particles inside the Schwarzschild singular sphere and to the problem of traversal of the sphere by the particles. (auth)

20789 RESONANCE IONIZATION OF ATOMS IN THE FIELD OF A STRONG ELECTROMAGNETIC WAVE. Kotova, L. P.; Terent'ev, M. V. (Kurnakov Inst. of General and Inorganic Chemistry, Moscow). Zh. Eksp. Teor. Fiz., 52: 732-41(Mar. 1967). (In Russian).

If the distance between the levels in an atom is a multiple of the light frequency, a resonance ionization mechanism may occur which consists in a real transition of the atom into the excited state after absorption of N photons which is then followed by ionization from the excited state. A general resonance formula for the probability of ionization of the atom under such conditions is derived which takes into account the possible presence of higher harmonics in the light beam. The possibility of a considerable increase of the probability as a result of resonance effects and the large width of the resonance are mentioned. (auth)

Cosmic Radiation

Refer also to abstracts 20618 and 20983.

20790 (AD-641509) COMPREHENSIVE MAP OF THE SPACE RADIATION ENVIRONMENT. Rosen, A.; Eberhard, C. A.; Farley, T. A.; Vogl, J. L. (TRW Space Technology Labs., Redondo Beach, Calif.). 1966. Contract AF 41(609)-1456. 272p. CFSTI $3.00 cy, $0.65 mn.

The handbook consists of two divisions; a space radiation map and a background information section. The term space radiation, as used in the handbook, includes high-energy particulate radiation: (a) electrons of energy greater than 10 keV (E > 10 keV); (b) protons: E > 50 keV; and (c) other charged and uncharged particles with atomic numbers Z > 1: E > 50 keV; and high-energy electromagnetic radiation (photons): E > 10 keV. (auth)

20791 THE 27-DAY VARIATIONS OF THE COSMIC-RAY DIURNAL VARIATIONS. Mori, Satoru (Univ. of Nagoya, Japan). J. Geomagnet. Geoelec., 18: 417-30(1966).

The 27-day variations of the cosmic-ray diurnal variations for 18 consecutive solar rotations of the last solar cycle were studied. During this period, a typical 27-day periodicity in the diurnal variations and the intensity changes of the cosmic rays was observed. With the presence of persistent solar plasma stream, it was found that the phase of the cosmic-ray diurnal variations changes periodically. Comparing the diurnal variations of the meson and the neutron components observed by several stations during these epochs, it is shown that the additional anisotropy producing the periodical changes of the diurnal variations could not be due to an addition of a single anisotropy in the interplanetary space. Assuming two anisotropies having different energy dependences outside the geomagnetic field, the observed changes of the diurnal variations at different places can be consistently explained. Namely, (1) the increase of the velocity of plasma stream from the sun can increase the additional flows of cosmic ray particles from the solar directions, and (2) the density gradient of cosmic-ray particles across the interplanetary magnetic field lines can produce the diffusion of the particles across the field lines (from 2 hr L.T.). The diffusion coefficient of the cosmic-ray particles across the magnetic field lines was estimated to be $\sim 10^{21}$ cm^2/sec for the particle of 10 GV and was proportional to the particle rigidity. (auth)

20792 DEPOLARIZATION AND CORRELATION METHOD OF POLARIZATION MEASUREMENT OF COSMIC RADIATION. Getmantsev, G. G.; Tokarev, Yu. V. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 170-4(1967). (In Russian).

Some peculiarities of the correlation method of measurement of the degree of linear polarization in cosmic radiation and the possibilities to determine, on its basis, the parameters of an interstellar magnetoactive medium, are considered. (auth)

20793 COSMIC-RAY INTENSITIES UNDER SEA-WATER AND UNDER ROCK. Creed, D. R.; Wolfendale, A. W. (Univ. of Durham, Eng.). Nuovo Cim. (10), 47A: 786-91(Feb. 21, 1967).

In a recent experiment Higashi et al. (Nuovo Cimento, 43A, 334(1966)) have measured cosmic-ray intensities under seawater and have found them to differ significantly from those measured previously under rock. Furthermore, the sea-level energy spectrum of muons derived from the underwater measurements is in better agreement with the directly measured spectrum than is the spectrum calculated from the data under rock. The validity of the argument is examined and it is concluded that at shallow depths (down to about 400 m water equivalent,) where no recent measurements have been made under rock, the underwater measurements are indeed superior, whereas at greater depths, from 400 to 1400 M.W.e., where precise measurements have been made recently under rock, there is no significant difference between the data. It is pointed out that underwater measurements at greater depths would be useful in that if comparison were made with the present under-rock measurements information could be gained on the magnitude of the energy-dependent component of the energy-loss relation for high-energy muons. (auth)

20794 A SEMI MONTE CARLO CALCULATION OF THE FLUX OF HIGH-ENERGY MUONS IN AIR SHOWERS. Lal, Siddheshwar (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 48A: 466-81(Mar. 21, 1967).

A semi Monte Carlo method was used to calculate the flux of muons of energy $\geq$180 GeV associated with air showers at sea-level, under various assumptions about the nature of nucleon and pion interactions at ultrahigh energies. Various aspects of these muons, viz. fluctuations in their number in showers of a given size, their growth curve in the atmosphere, integral energy spectrum and variation in their number with the energy of the shower associated with them were obtained under different assumptions with a view to see if it can throw any light on the characteristics of ultrahigh-energy nuclear collisions. (auth)

20795 ABSOLUTE FLUX OF HYPOTHETICAL PRIMARY COSMIC PHOTONS WITH ENERGY 10^{15} eV. Gawin, Jerzy; Maze, Roland; Wdowczyk, Jerzy; Zawadzki, Alexandre (Laboratoire de Physique Cosmique, Verrieres-le-Buisson, France. Institut des Recherches Nucleaires, Lodz, Poland). Compt. Rend., Ser. B, 264: 87-8(Jan. 4, 1967). (In French).

The existence of large atmospheric clouds poor in muons suggest the presence of primary cosmic photons with an energy of approximately 10^{15} eV. However, the recent discovery of low energy photons (3°K) with a high density (500 cm^{-3}) should have a repercussion: a destructive interaction $\gamma + \gamma \rightarrow e^- + e^+$ can be expected beginning at approximately 3×10^{14} eV. However, if the clouds come from the primary photons their energy and their flux can be determined as 6×10^{-9} m^{-2} sec^{-1} $srad^{-1}$ at 8×10^{14} eV. These two phenomena: the simultaneous presence in the universe of photons at 3°K and at $\sim 10^{15}$ eV are difficult to reconcile. (tr-auth)

20796 LONG-TERM VARIATION IN THE MAGNITUDE OF THE DIURNAL ANISOTROPY OF COSMIC RAYS. Duggal, S. P. (Franklin Inst., Swarthmore, Pa.); Pomerantz, M. A.; Forbush, S. E. Nature, 214: 154-5(Apr. 8, 1967).

Of the several effects of modulation of cosmic rays which are solar in origin the diurnal variation is the most difficult to investigate because of its small amplitude. Precise determination of both the long term and day-to-day characteristics of the diurnal anisotropy is of great importance in the development of theoretical models of the processes whereby the sun exercises control over electromagnetic conditions in the inner solar system. Different workers have reached widely divergent conclusions concerning even the gross features of the yearly average solar diurnal variation vector. The objective of the investigation described was to acertain, by critical application of rigorous statistical techniques to the considerable data available, what can be quantitatively concluded concerning the long term behaviour of the solar diurnal variation. The results of an analysis of the data recorded at 13 stations in 1958 (minimum cosmic-ray intensity) and 1965 (maximum) are tabulated. The average reduction in amplitude of the yearly mean diurnal variation vector between 1958 and 1965 was 26%. The results, based on neutron monitor observations, indicate that the mean anisotropy is not invariant, and that the year of cosmic-ray maximum of the last solar cycle was characterized by a statistically significant reduction in amplitude from the epoch of cosmic-ray minimum. Records indicate that amplitude reductions also occurred in 1944 and 1954, the two preceding years of maximum cosmic-ray intensity. (UK)

20797 INDICATOR ABOUT THE MODULATION OF GALACTIC COSMIC RAYS BY THE SOLAR WIND. Nestorov, G. (Geophysical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 1009-10(1966).

The behavior of absorption of radio waves with a frequency of 164 kc along the Allouis–Sofia path was examined previously. Absorptions for the summer months of the last eight years are plotted, and an attempt is made to deduce the amount of solar modulation of the galactic cosmic radiation. (W.D.M.)

20798 COSMIC-RAY VARIATIONS ACCORDING TO DATA FROM ZOND-3 AND VENERA-2. Vernov, S. N.; Chudakov, A. E.; Vakulov, P. V.; Logachev, Yu. I.; Lyubimov, G. P.; Pereslegina, N. V. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 171: 583-6(Nov. 21, 1966). (In Russian).

At the end of 1965 and beginning of 1966 two Soviet space stations, Zond-3 and Venera-2, were simultaneously measuring cosmic-ray intensity. The first was in motion away from the Sun and the second toward the Sun, which made it possible to determine both variations in the intensity of cosmic rays and their dependence on the distance from the Sun (i.e., their radial gradient). Data obtained by STS-4-type gas-discharge counters onboard the spacecraft revealed the radial gradient as $\delta = (3.1 \pm 0.4)\%$/A. U. The radial gradient was irregular; this phenomenon was attributed to changes in the character and magnitude of the Forbush effect. Detectors of the n–p type onboard the space stations measured the radial gradient of protons with energies of 1 to 5 MeV. In addition to a sharp temperature increase, the detectors revealed a very stable and time-independent noise which exceeded by about 10 times the possible noise of high-energy particles. It was also found that the intensity of protons increased in moving away from the Sun. When the distance from the Sun was increased from 130×10^6 to 190×10^6 km, the intensity of 1- to 5-MeV protons, whose origin is shown to be solar, increased 5 times. A mechanism is proposed for explaining this paradox. The nature of the radial gradient may possibly be explained by Parker's diffusion theory. (ATD)

20799 OBSERVATIONS ON NUCLEI HEAVIER THAN IRON IN THE PRIMARY COSMIC RADIATION. Ormes, J. F.; von Rosenvinge, T.; Weber, W. R. (Univ. of Minnesota, Minneapolis). Astrophys. J., 147: 1205-9(Mar. 1967).

In the course of a systematic study of the charge, energy spectra, and solar modulation effects on nuclei with charge from 1 to 26, a series of more than ten balloon flights were made with a Cherenkov scintillation counter of geometrical factor ≃50 sterad cm^2. A total of ≃ nuclei in the iron group were observed. At most 2 nuclei with $Z \geq 34$ were identified, giving a lower limit to the very heavy/super heavy ratio of 1000:1. (W.D.M.)

20800 NATURE OF NUCLEAR-ACTIVE PARTICLES AT THE MOUNTAIN ALTITUDE. Murzin, V. S.; Bashindzhagyan, G. L.; Erofeeva, I. N.; Mishchenko, L. G.; Rapoport, I. D.; Sarycheva, L. I. (Moscow State Univ.). Yadern. Fiz., 5: 612-15(Mar. 1967). (In Russian).

The part of pions in the total flux of nuclear-active particles with the mean energy 350 GeV is found to be not less than 20% at the atmosphere depth 700 $g \cdot cm^{-2}$. An ionization calorimeter and a hodoscope were used. (auth)

20801 ENERGY SPECTRA OF CASCADE ELECTRONS IN Pb. Ivanenko, I. P.; Samosudov, B. E. (Moscow State Univ.). Yadern. Fiz., 5: 622-5(Mar. 1967). (In Russian).

The energy spectra of cascade electrons in Pb were calculated using the momentum method. The calculations were performed including all processes significant for the interaction of radiation with matter in a broad region of primary (10^7 to 10^{13} eV) and secondary (0 to 10^7 eV) particle energies. The results are in good agreement with calculations of electron–photon showers by the Monte Carlo method and with the experimental data. (auth)

20802 INVESTIGATION OF COSMIC RADIATION BY THE LUNA-10 ARTIFICIAL SATELLITE. Grigorov, N. L.; Maduev, V. L.; Pisarenko, N. F.; Savenko, I. A. (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 170: 565-6(Sept. 21, 1966). (In Russian).

Protons with energies exceeding 50 MeV and electrons with energies greater than 5 MeV were recorded by an end-window gas discharge counter carried on Luna-10. This counter was protected by a 2.5 g/cm^2 copper shield. The soft radiation (protons with energies >0.5 MeV and electrons with energies >40 keV) was registered by another counter of the same type which was also shielded by copper but had, in addition, a 1.2 mg + 0.3 mg/cm^2 mica and gold sheet forming a small window 0.5 cm in diameter. The total geometry factor of the counters for the isotropic hard radiation was 2.6 ± 0.2 cm^2. The counting rate was recorded on a logarithmic scale. The error in transmission of the radiation count data did not exceed 3%. The average count rate of hard radiation recorded between March 31 and April 3, 1966, was 12.2 ± 0.1 particles/sec, which corresponds to a flux of 4.7 ± 0.4 particles/cm^2 sec. The data indicate that the intensity of primary cosmic radiation is characteristic for the minimum solar activity cycle. Luna-10 was placed in a selenocentric orbit on April 3, 1966, with an apogee of 1000 km, a perigee of 350 km, and an angle of inclination of 72° with respect to the moon's axis. (ATD)

20803 DETERMINATION OF THE FLUX OF PRIMARY COSMIC RAY HYDROGEN AND HELIUM NUCLEI NEAR THE GEOMAGNETIC EQUATOR USING NUCLEAR EMULSIONS. III. THE FLUX OF DEUTERONS ON MARCH 12, 1960, AT HYDERABAD. Ganguli, S. N.; Rao, N. K.; Swami, M. S. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 65: 19-24(Jan. 1967).

Nuclear emulsions exposed to cosmic radiation over Hyderabad, India, at an altitude of 31.3 km for six hours, were used to determine primary cosmic-ray deuteron flux. The flux of deuterons of rigidity ≥ 16.9 GV at the top of the atmosphere was found to be <10 m^{-2} sec^{-1} $sterad^{-1}$; this may be compared with the proton flux of 83 ± 12 m^{-2} sec^{-1} $sterad^{-1}$ in the same rigidity region over Hyderabad. (auth)

Direct Energy Conversion

20804 (AD-640184) RESEARCH ON THERMIONIC ELECTRON EMITTING SYSTEMS. Final Report, June 16, 1965–September 15, 1966. Weissman, I. (Varian Associates, Palo Alto, Calif.). Sept. 15, 1966. Contract NObs-92494. 100p. CFSTI $3.00 cy, $0.65 mn.

The synthesis and evaluation of a unique type of thorium, thin-film, thermionic electron emitter are discussed. The synthesis procedure involves chemical vapor deposition of a surface layer of a refractory metal onto a thorium dispensing substrate. The unique features of the process are a high degree of preferred uniaxial crystal orientation which can be obtained in the deposited layer, and a measure of control over the particular direction in the layer that is preferentially oriented. By virtue of this orientation, surfaces can be fabricated consisting predominantly of one of the better emitting crystal planes of the particular combination of substrate and adsorbate and enhanced emission thus realized. In the majority of this year's work the grain-oriented surface layers investigated were tungsten. Three different types of dispensers were evaluated, each utilizing a different thermochemical reaction for production of the free thorium necessary to sustain the surface coverage at emitting temperatures. Both thermal stability of preferred orientation and thermionic emission capabilities were evaluated. Methods were evolved for fabricating the emitting structures so as to enhance thermal stability. The emitters tested exhibited a spread of over 15% in their measured values of vacuum work function (3.0 to 3.55 eV). With a single exception they exhibited high thermionic constants (70–120). Thermal stability was good for one type of dispenser evaluated, and relatively poor for the other two. (TAB)

20805 (AD-642769) RESEARCH PROGRAM ON APPLICATION OF JET COMPRESSORS TO MAGNETOPLASMADYNAMIC ELECTRICAL POWER GENERATION. PHASE II. Final Tech-

nical Report, June 1, 1965–October 31, 1966. Bienert, Walter B. (Martin Co., Baltimore, Md.). Nov. 15, 1966. Contract Nonr-4876(00). 88p. (MND–3277). CFSTI $3.00 cy, $0.65 mn.

The feasibility of using jet compressors in closed cycle MPD systems was investigated. In jet compressors the thermal energy of a driving gas is converted into kinetic energy and subsequently used to compress a second gas. The thermal energy could be obtained from the residual energy of the exhaust of an MPD generator. A thermodynamic analysis of a jet compressor was made which showed that an ideal device in which both fluids mix at equal forward velocities has the same pressure ratio as a reversible engine. Theoretical expressions for the losses due to irreversible mixing of the fluids were derived. A comparison of a jet compressor system with one using rotating machinery was made. Jet compressors appear feasible, provided that a slightly lower overall efficiency can be tolerated. An experimental single stage jet compressor using cesium and helium as working fluids was built and operated. Pressure ratios up to 1.48 of the helium were measured which correspond to approximately 90% of the theoretical value. The experimental compression work was over 50% of that of a reversible engine. It is estimated that in a large, optimized system 80–90% of the reversible compression work can be obtained. (auth)

20806 (IPP–3/49) DIE VERMINDERUNG DER SPANNUNGEN UND STROEME DURCH DIE ENDLICHE SEGMENTIERUNG IN FARADAY- UND HALL-GENERATOREN. (On the Current and Voltage Losses Caused by Finite Electrode Segmentation in Faraday and Hall Type MHD Generators). Lengyel, L. L. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec. 1966. 27p. (In German). Dep. mn.

The experimental results presented at the Third International Symposium on MHD Electrical Power Generation in Salzburg indicate that there is a significant discrepancy between the experimentally measured Hall and Faraday voltages and the theoretical values computed by means of idealized mathematical models. An attempt is made here to estimate the voltage losses caused by the finite electrode segmentation alone at various values of the Hall parameter. (auth)

20807 THIN SILICON SOLAR CELLS FOR LARGE FLEXIBLE ARRAYS. Crabb, R. L.; Treble, F. C. (Royal Aircraft Establishment, Farnborough, Eng.). Nature, 213: 1223-4 (Mar. 25, 1967).

The use of solar-powered electrical propulsion systems for spacecraft is discussed. Such use can give a marked payload advantage over chemically powered spacecraft. It has been shown theoretically that it is possible to change independently all the elements of a spacecraft's orbit by means of small continuous thrusts from an electrical propulsion unit. The ability to change the inclination of an orbit would make it possible for a communications satellite launched from a non-equatorial site to attain a geostationary orbit. Silicon solar cells offer a promising approach to the problem of providing kilowatts of power over several years. The most important requirements for large arrays are low specific mass and the ability to stow and support the assembly in small volume for launching. A significant saving can be achieved by using a thin plastic substrate instead of the conventional rigid support, and reducing the thickness of the solar cells. Such assemblies are sufficiently flexible to permit large areas to be wrapped around the spacecraft body or around a separate drum. A reduction in cell thickness from 400 to 100 μ has been achieved. Data are shown from experiments on 100 to 400 μ shallow junction 10 Ω n-on-p silicon cells. An interesting feature of thin silicon cells is their radiation resistance. This would be of particular value in traversing the Van Allen proton belt. (UK)

20808 CALCULATION OF MAGNETOHYDRODYNAMIC FLOW IN A DUCT WITH SECTIONALIZED ELECTRODES. Kaidalov, V. A.; Khanzhina, E. I.; Yantovskii, E. I. Magnit. Gidrodin., No. 4, 55-61(1966). (In Russian).

Methods for calculating magnetohydrodynamic duct flow using the quasi-one-dimensional approach are presented, and the Hall effect, friction, heat exchange, and potential drop near the electrodes are taken into account. Corrections due to dimensions of sectionized electrodes were estimated. To illustrate the methods, two examples for a supersonic flow calculation in MGD-converter duct with the load resistance connected across the duct terminals are presented. (auth)

20809 SELF-EXCITATION OF CERTAIN ELECTROMECHANICAL SYSTEMS. Yantovskii, E. I. Magnit. Gidrodin., No. 4, 126-32(1966). (In Russian).

A transient self-excitation process in an autonomous electromechanical system of a driving device (pump) and MHD converter is considered. It is shown that at a sufficiently high velocity the system is self-exciting and stationary, and the stable regime in the electric circuit can be obtained only if the pump head is decreasing with the increasing of velocity. (auth)

20810 EXPERIMENTAL INVESTIGATION OF ASYNCHRONOUS MHD CONVERTER WITH LIQUID METAL ROTOR AT SELF-EXCITATION REGIME. Glukhikh, V. A.; Kirillov, I. R. Magnit. Gidrodin., No. 4, 107-14(1966). (In Russian).

The results of an experimental investigation of an alternating current MHD converter with a liquid metal rotor at the self-excitation regime are discussed. Experimental data are compared with the theoretical ones obtained from the existing induction pump theories. They are found to be in a satisfactory agreement. The possibility of converter's self-excitation and its steady running in the case of unsaturated core was verified. (auth)

20811 DETERMINATION OF MEAN CURRENT IN THE DUCT IN THE PRESENCE OF INDUCED MAGNETIC FIELDS. Eliseev, B. V.; Lobanov, A. D. Magnit. Gidrodin., No. 4, 133-5(1966). (In Russian).

For the determination of magnetic fields induced in a two-dimensional converter duct, an integral equation was used. Solution of this equation, derived by means of approximate methods and approximate formulas for the mean current, are presented in two limiting cases. The velocity distribution is given. (auth)

20812 BOUNDARY LAYER ON THE INSULATOR WALL AND ITS INFLUENCE ON THE MAGNETOHYDRODYNAMIC DEVICE PARAMETERS. Apollonskii, S. M.; Kos'kin, Yu. P. Magnit. Gidrodin., No. 4, 39-48(1966). (In Russian).

Calculation methods and the results of analysis are presented of the laminar compressible boundary layer on the insulator wall in an MHD device duct with the anisotropy of conductivity taking into account. The flow velocity in the core is assumed to be constant while the temperature changes according to the linear law. Expressions for the leak current, friction coefficients, and heat conductivity are presented. A calculation on the electronic computer M-20 was carried out. Equations and calculation results are discussed. (auth)

20813 OPTIMUM MHD CONVERTERS. Shakhnov, I. I.; Shcherbakov, V. T. Magnit. Gidrodin., No. 4, 49-54(1966). (In Russian).

Maximum-power dc converters are considered. Equations are considered for expressing quasi-one-dimensional plasma channel flow, which is an additional condition for functional power. Thus, the problem of conditional extremum with isoparametric restrictions is formulated. A system of differential equations was investigated by means of numerical integration using a computer. The illustrative material for particular examples is presented, and an approximate general relationship for the optimum duct parameters was obtained. (auth)

20814 UP-TO-DATE PROSPECTS OF MHD ENERGY CONVERSION IN A CLOSED CYCLE. Croitoru, Z. Magnit. Gidrodin., No. 4, 3-10(1966). (In Russian).

Some prospects of MHD energy conversion in a closed cycle are discussed. The importance of the economic aspects study, which has to precede the development of the large-scale research to ascertain the possibility of different constructions of the converter, is stressed. The essential features of MHD converters with segmented semiconducting electrodes are described. (auth)

20815 ELECTRICAL PARAMETERS OF THE DC MHD GENERATOR WITH ARBITRARY CONNECTED ELECTRODES. Celinski, Z. N. (Inst. of Nuclear Research, Warsaw). Advanced Energy Convers., 6: 223-31(Oct.-Dec. 1966).

The general connection system of the electrodes in the MHD generator is defined, the special cases of which are the well-known generator types. Electrical parameters of this generator type were calculated using the complex plane. Constant gas-dynamic parameters and constant channel cross section were assumed. (auth)

20816 METHOD OF PRODUCING ELECTRICITY BY MEANS OF A MAGNETOHYDRODYNAMIC GENERATOR. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,059,727. Feb. 22, 1967. Priority date Oct. 10, 1962, Germany.

A method of producing electricity by means of a magnetohydrodynamic generator operating with a seeded plasma is described. Consideration is given to cooling of one of the electrodes so that the working surface is maintained at a temperature which is just below the melting point of the material of which the electrode is made, and so that the border layer of the plasma adjacent to the working surface is maintained at such a temperature that there is formed on the working surface a thin emission layer comprising constituents of the plasma. In this method, the electrodes are subjected, not to forced cooling, but to controlled cooling. The temperatures necessary for this purpose at the metallic working

surface of the electrode amount to at least 1100°C. High-grade steels resistant to scaling and oxidation are suitable for the electrode materials. (J.H.M.)

20817 METHOD OF OPERATING MHD DEVICES WITH IMPROVED ELECTRODES. (to Avco Corp.). British Patent 1,060,456. Mar. 1, 1967. Priority date Jan. 6, 1964, United States.

A method for improving the performance of the electrodes of magnetohydrodynamic generators is described. On the exposed end surface of the electrodes, a high-temperature material is used that has an electron emissivity of at least one ampere per square centimeter at 1500°K. The suggested material is zirconium oxide or chromic oxide. (J.H.M.)

20818 IMPROVEMENTS IN POWER GENERATION APPARATUS. (to General Electric Co.). British Patent 1,062,722. Mar. 22, 1967. Priority date Feb. 3, 1964, United States.

A description is given of an electric power generation apparatus in the form of a thermionic converter used in a nuclear reactor for operating at temperatures above 2000°K in order to obtain efficient operation and optimized electrical power generation. (J.H.M.)

20819 THERMOELECTRIC APPARATUS. (to United States Atomic Energy Commission). British Patent 1,062,739. Mar. 22, 1967. Priority date July 25, 1963, United States.

A self-contained thermoelectric generator powered by a radioactive heat source is described. An improved fuel form and improved thermoelectric elements are included in the system. (J.H.M.)

20820 METHOD AND APPARATUS FOR OPERATING PLANT WORKING ON A HIGH-TEMPERATURE CLOSED CYCLE. (to Brown Boveri and Co. Ltd.). British Patent 1,062,760. Mar. 22, 1967. Priority date Apr. 21, 1964, Switzerland.

A high-temperature closed cycle power plant with a magnetohydrodynamic generator is described. In the system described, the combustion gases, after partial use of their energy, are cooled before they enter an air heater to heat the combustion air for the cycle. (J.H.M.)

20821 GENERATION OF ELECTRICITY BY MEANS OF A MAGNETOHYDRODYNAMIC GENERATOR. (to Siemens-Schuckertwerke AG). British Patent 1,064,468. Apr. 5, 1967. Priority date Aug. 6, 1963, Germany.

A method of generating electricity by means of an MHD generator is described, wherein seed material, which is solid when at room temperature, is heated to a temperature above its melting point by waste gases of the generator and is then supplied in fluid form to a combustion chamber of the generator. (M.H.R.)

20822 MAGNETOHYDRODYNAMIC GENERATOR EMPLOYING A FLUID AT A NONUNIFORM TEMPERATURE. Ricateau, Pierre; Zettwoog, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,063,621. Mar. 30, 1967. Priority date Mar. 29, 1963, France.

A magnetohydrodynamic generator is described that has the means to operate so as to modulate the temperature of the converter gas. The unit for modulating the gas temperature employs an even number of electrodes, one-half of the number being arranged on each side of the path followed by the gas and uniformly spaced apart along the path. The materials and structural arrangements which are suitable for an MHD generator of ordinary design are all the more suitable in the case of a design using the modulation unit. (J.H.M.)

Fluid Physics

Refer also to abstracts 20630, 20684, 20698, 20808, 20857, and 20995.

20823 (ORNL–3707) HYDROMAGNETIC STABILITY OF VORTEX-LIKE FLOW. Chang, T. S.; Sartory, W. K. (Oak Ridge National Lab., Tenn.). Jan. 1966. Contract W-7405-eng-26. 172p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A hydromagnetic stability analysis of conducting incompressible, vortex-like flow with possible applications to the ionized-gas-phase fission reactor and plasma power-generation concepts is presented. It is found that, in general, a conducting vortex-like flow between coaxial cylindrical walls can be stabilized against the initial breakdown of laminar motion by means of an axially applied magnetic field of sufficient strength. The analysis shows, in particular, that for incompressible, conducting, inviscid, pure-vortex flow or nondissipative Couette flow, exact criteria for hydromagnetic stabilization may be deduced. This analysis also considers the stability of dissipative, conducting, incompressible, pure-vortex flow between perfectly conducting rotating walls in the presence of an axially applied magnetic field. Numerical results are also obtained for the stability of dissipative Couette flow between perfectly conducting or insulating walls. Three cases are considered: (1) co-rotating walls, (2) stationary outer wall, and (3) counter-rotating walls. Approximate results based on the assumption of a narrow gap between the rotating walls are also obtained. These results are compared with those of the exact wide-gap analysis. The stability of vortex-like flow with radial flow between rotating permeable walls is also considered. The walls are assumed to be perfectly conducting, and a small magnetic Prandtl number is again assumed. Numerical results are obtained for a stationary outer wall with inward and outward radial flow. In considering radial flow and an axial magnetic field as possible methods of stabilizing vortex-like flow, it is noted that although a sufficient increase in the magnitude of either the radial flow or the magnetic field will tend to stabilize the flow, the two effects are not entirely complementary. (auth)

20824 THE FLOW OF CONDUCTING FLUIDS IN CIRCULAR PIPES WITH FINITE CONDUCTIVITY UNDER UNIFORM TRANSVERSE MAGNETIC FIELDS. Ihara, Sadatoshi (Waseda Univ., Tokyo); Tajima, Kiyohiro; Matsushima, Akira. J. Appl. Mech., 34: 29-36 (Mar. 1967).

The flow of incompressible, viscous, electrically conducting fluids in circular pipes in the presence of an applied transverse magnetic field is analyzed theoretically and experimentally. The relations among the Hartmann number, the Poiseuille number, skin friction coefficient, the Reynolds number, sensitivity, and wall conductivity are discussed. The experimental results using carbon pipe, stainless steel pipe, and glass pipe are in good agreement with theoretical calculations. (auth)

20825 FIELD-ALIGNED FLOW OF A CONDUCTING FLUID PAST A SOURCE OF MAGNETISM. Winter, D. F.; Gerwin, R. A. (Boeing Scientific Research Labs., Seattle). Appl. Sci. Res., 17: 14-30(1967).

A prescribed source of magnetism moves at constant speed through a viscous conducting incompressible fluid with an aligned uniform magnetic field. The velocity and magnetic fields induced at a distance from the source are calculated. The induced fields are also calculated for the case in which the applied field is absent. Although no special symmetry or alignment is assumed, the source is "ideal" in the sense that enclosures (wires or magnets) are infinitesimal in at least two dimensions. Dynamical interactions will occur in a viscous fluid and their effect in the far field is estimated. As a consequence of finite conductivity and viscosity, the usual wakes are present which trail or lead the source depending upon the sign of $(1 - A^2)$, where A is the ratio of the source speed to the Alfvén speed in the undisturbed fluid. Outside the wake the total perturbation magnetic field due to the source is the static field plus a monopole field, divided by $(1 - A^2)$. An estimate is also made of the rate at which energy is dissipated as a consequence of viscous interactions and ohmic heating throughout the fluid, outside the immediate vicinity of the source. (auth)

20826 SUPERSTRONG MAGNETIC GENERATORS. Sakharov, A. D. Usp. Fiz. Nauk, 88: 725-34(Apr. 1966). (In Russian).

The design and construction of superhigh magnetic generators are described. Detailed descriptions are given of various stages of performance of the MC-1 and MC-2 magnetocumulative generators, and their magnetic-flux-compressing properties are discussed. (R.V.J.)

20827 PARTICULAR SOLUTIONS IN SPHERICAL COORDINATES IN MAGNETOFLUIDDYNAMICS. Levoni, Sergio (Univ., Modena, Italy). Atti Seminar. Mat. Fis. Univ. Modena, 15: 46-61(1966). (In Italian).

A nonviscous incompressible fluid with infinite electric conductivity and with axial symmetry is considered in the stationary regime. The Bernoulli and vorticity equations in spherical coordinates are considered and these last equations are studied for a particular case. Some particular solutions are placed in relation with boundary problems. (tr-auth)

20828 FORCE-FREE FIELDS OF MAGNETOFLUIDDYNAMICS. Ferrari, Italo (Univ., Modena, Italy). Atti Seminar. Mat. Fis. Univ. Modena, 15: 62-74(1966). (In Italian).

The equations for the general case are derived in cylindrical coordinates. A solution is then sought with the magnetic field normal at all points to the coordinate line. Classes of solutions in polar coordinates are then derived. (J.S.R.)

20829 NONLINEAR DIFFUSION PROBLEM OF THE MAGNETIC FIELD. Primicerio, Mario (Univ., Florence). Atti Seminar. Mat. Fis. Univ. Modena, 15: 75-86(1966). (In Italian).

In a previous study the space–time evolution of the magnetic field in an infinite region, limited by two parallel planes, occupied by a compressible fluid of constant conductivity, was determined

for the case where one of the two planes was moving normal so as to compress the fluid present. In the present work a solution is sought for the problem in the case the where the velocity of the "piston" is not assigned but treated only as an external force acting on it, maintaining the hypothesis of quasi staticity. The compression velocity is then determined as a function of such force and as a function of pressure exercised on the fluid. The treatment in the previous work is therefore generalized to the case of arbitrary velocity of one plane. The nonlinear case is then considered. (J.S.R.)

20830 EXPERIMENTAL STUDY OF THE INFLUENCE OF LONGITUDINAL MAGNETIC FIELD ON CONVECTIVE HEAT TRANSFER IN TURBULENT PIPE FLOW OF CONDUCTING FLUID. Kovner, D. S.; Krasil'nikov, E. Yu.; Panevin, I. G. Magnit. Gidrodin., No. 4, 101-6(1966). (In Russian).

Experimental study of the influence of the longitudinal magnetic field on convective heat transfer in turbulent pipe flow of a conducting fluid (gallium) was carried out at the Hartmann number 380 and 550, and Peclet number varying from 160 till 3100. An empirical relationship is proposed allowing one to calculate the convective heat transfer in turbuient pipe flow of a conducting fluid in the presence of longitudinal magnetic field. (auth)

20831 ONE-PARAMETER CURRENTS OF AN IDEAL GAS OF INFINITE ELECTROCONDUCTIVITY. Terpugov, A. K. Vestn. Leningr. Univ., No. 19, Ser. Mat., Mekh. Astron., No. 4, 108-15(1966). (In Russian).

The flow of an ideal compressible gas of the infinite electric conductivity is considered in space coordinates, the unknown values being functions of one parameter. Such coordinates describe the flow over linear plane surfaces, and they are a generalization of analogous gasdynamic currents. (TSS)

20832 NEGATIVE SEARCH FOR WALL CONDUCTIVITY IN DISCHARGE TUBES. Clotfelter, B. E. (Grinnell Coll., Iowa). J. Chem. Phys., 46: 2850-1(Apr. 1, 1967).

Twelve discharge tubes were constructed in a serach for effects previously attributed to electric conductivity of the glass walls of discharge tubes in contact with flowing plasma. The tubes had probes of various materials and in various positions relative to the tube walls. Gas pressure, input energy, and magnetic fields were all varied. In no tube and under no conditions was a suggestion of wall conductivity found. It is suggested that the effect previously attributed to wall conductivity could have been produced by a large series resistance in the circuit. (A.G.W.)

20833 CONDUCTING FLUID FLOW IN A FLAT CHANNEL OF ARBITRARY FORM. Dorfman, A. Sh.; Pol'skii, N. I. Magnit. Gidrodin., No. 4, 62-8(1966). (In Russian).

Incompressible fluid flow with constant conductivity in a flat symmetrical channel is discussed. Magnetic- and electric-field functions were assumed to be given as well as a small magnetic Reynolds number. Linearization is carried out by the substitution of one coefficient by the self-similar solution. The second iterational term is neglected and the first is substituted by its mean value across the channel. The expression for the velocity is obtained in the form of eigenvalue function series associated with some linear operator. In order to find the pressure gradient, a Volterra-type integral equation was derived. The series coefficients and some integral equation terms do not depend on the particular problem and can be tabulated once for all. The computations of a channel of arbitrary form is essentially simplified by this procedure. (auth)

20834 CONDUCTING FLUID FLOW PAST A FLAT PLATE IN THE PRESENCE OF TRANSVERSE MAGNETIC FIELD. Gurevich, B. Ya.; Miller, R. L.; Tsinober, A. B.; Shtern, A. G. Magnit. Gidrodin., No. 4, 69-77(1966). (In Russian).

The conducting fluid boundary layer on a flat plate in the presence of transverse magnetic field was investigated. The theoretical part deals with an analytical solution of the magnetohydrodynamic boundary layer problem, carried out by means of integral method and expansion in series, convergent at arbitrary Stuart numbers. The series appear to converge to exact solution representing the asymptotic behavior of the boundary layer. It is possible to present the velocity profile by means of several series terms at arbitrary Stuart numbers with sufficient degree of accuracy. The numerical calculation of the problem was carried out too. The experimental part deals with velocity distribution measurements in a boundary layer. The obtained results are discussed. (auth)

20835 TURBULENT FLOW IN THE PLANE PERPENDICULAR TO THE MAGNETIC FIELD. Branover, G. G.; Vasil'ev, A. S.; Gel'fat, Yu. M.; Shcherbinin, E. V. Magnit. Gidrodin., No. 4, 78-84(1966). (In Russian).

Experimental investigation of the mercury flow in flat channels was carried out in the presence of magnetic field parallel to the longest side of the channel cross section. A remarkably more intensive damping of turbulence than in the presence of longitudinal magnetic field was established. To determine the minimum resistance coefficient empirical formulas are presented. (auth)

20836 PARAMETRIC COMPUTATION METHOD FOR THE LAMINAR BOUNDARY LAYER IN MAGNETOHYDRODYNAMICS. Yuferev, V. S. Magnit. Gidrodin., No. 4, 85-91(1966). (In Russian).

A laminar conducting-fluid boundary layer at small magnetic Reynolds number in the presence of transverse magnetic field is discussed. The fluid density, viscosity, and conductivity are assumed to be constant. An equation for the boundary layer is derived, and its numerical integration in one-parameter approach is discussed. (auth)

20837 MAGNETOHYDRODYNAMIC COUETTE FLOW OF VISCOUS PLASTIC FLUIDS. Makarov, A. M.; Martinson, L. K.; Pavlov, K. B. Magnit. Gidrodin., No. 4, 92-4(1966). (In Russian).

The influence of fluids on plastic properties of MHD Couette flow in annular gaps in the presence of a radial magnetic field was investigated. (auth)

20838 CAPILLARY RISING IN MAGNETOHYDRODYNAMICS. Zambran, A. P. Magnit. Gidrodin., No. 4, 95-100(1966). (In Russian).

The differential equation for conducting liquid meniscus motion in a capillary due to surface tension in the presence of transverse magnetic field was solved. Solution of the equation mentioned above is given in the form of infinite series. It provides the possibility to determine the velocity with any required accuracy at any place of the path. It is shown that capillary rising velocity changes are described by Hartmann number and the equilibrium height depends on non-dimensional group $Q = (\sigma EB/\rho q) = (MNFr/Re^2)$. Experiments with mercury and electrolytes show a good agreement with theoretical results. (auth)

20839 CONDUCTING GAS FLOW IN A SUPERSONIC NOZZLE. Katskova, O. N.; Chushkin, P. I. Magnit. Gidrodin., No. 4, 11-18 (1966). (In Russian).

A perfectly conducting gas in supersonic flow in a nozzle at small magnetic Reynolds numbers in the presence of magnetic field is discussed. A numerical method adapted to electronic computers is developed for solution of the problem. Certain calculated results describing the gas flow in two-dimensional and axisymmetric cases are presented at different values of a uniform longitudinal magnetic field. (auth)

20840 HYSTERESIS EFFECTS IN TWO-DIMENSIONAL MGD FLOWS. Dzhaugashtin, K. E.; Fomenko, B. A. Magnit. Gidrodin., No. 4, 26-32(1966). (In Russian).

A stationary laminar conducting gas flow between moving plates and coaxial cylinders in the presence of transverse magnetic field is discussed. The equations are integrated by means of quadratures. The effectiveness of hysteresis phenomena connected with the dependence of plasma conductivity on temperature is shown. (auth)

20841 TURBULENT MAGNETOHYDRODYNAMIC BOUNDARY LAYER IN COMPRESSIBLE FLUID. Ginzburg, I. P.; Skurin, L. I. Magnit. Gidrodin., No. 4, 33-8(1966). (In Russian).

As a result of approximate solution of the problem of incompressible constant-conductivity fluid flow past a plate at small magnetic Reynolds number in the presence of transverse magnetic field, a dependence of local and full friction factor from the magnetic interaction parameter was obtained. For the turbulent boundary layer, this dependence is less pronounced than for the laminar one. The following results are verified: (1) the decreasing of friction occurs due to energy losses in the outer flow resulting from the work which is done against the magnetic field (the boundary layer thickness is independent of magnetic field); and (2) in the presence of magnetic field the universal law of velocity profile is not valid in the turbulent part of the boundary layer. (auth)

20842 STABILITY OF BAROCLINIC FLOWS IN A ZONAL MAGNETIC FIELD. PART II. Gilman, Peter A. (Massachusetts Inst. of Tech., Cambridge). J. Atmos. Sci., 24: 119-29 (Mar. 1967).

The equations of Part I are approximated to represent a two-layer model. All the theorems for the continuous case are shown to hold in the two-layer case as well. In addition, bounds are placed on the phase velocities of neutral waves. The stability of purely baroclinic flow (no horizontal shear) in a uniform zonal magnetic field is then studied. The minimum vertical shear needed for instability no longer depends upon the β-effect or the static stability, but rather is determined by the zonal field strength. Short waves are destabilized by the magnetic field, long waves

stabilized. Unstable waves convert available potential energy into kinetic energy of the disturbances, part of which in turn is converted into disturbance magnetic energy. Nonmagnetic changes in the initial state are similar to those of Phillips. Perturbation vertical magnetic fields and a single-celled meridional (poloidal) field are produced. (auth)

20843 STABILITY OF BAROCLINIC FLOWS IN A ZONAL MAGNETIC FIELD. PART III. Gilman, Peter A. (Massachusetts Inst. of Tech., Cambridge). J. Atmos. Sci., 24: 130-43 (Mar. 1967).

The study of the stability of two-layer baroclinic flows in a zonal magnetic field (Part II) is generalized to include a parabolic flow profile in the upper layer. Contrary to the nonmagnetic case, singularities may be present in the equations even when the potential vorticity gradient does not change sign, if the magnetic field is increased beyond a certain strength. Below this strength, power series solutions show that, just as in the nonmagnetic case, horizontal shear renders shorter waves unstable. Reynolds stresses are seen to transport momentum up the gradient, while smaller Maxwell stresses oppose them. Properties of the solutions are compared to solar observations. At gas densities $\sim 10^{-4}$ gm cm^{-3}, an ~35K equator-pole temperature difference would be enough to give baroclinically unstable disturbances in a zonal field of 100 gauss. The perturbation vertical fields produced from this magnitude zonal field will have magnitude ~1 gauss, as well as a zonal wave number of 6-8, "e folding" times of a few solar rotations, and a pronounced tilt upstream away from the maximum of zonal flow. All these characteristics are qualitatively consistent with the solar observations. The Reynolds and Maxwell stresses are seen to act in such a way as to be capable of maintaining the solar differential rotation in the manner proposed by Starr and Gilman. It is suggested that the same process could be used to maintain differential rotation in the dynamo theory. The production of perturbation vertical and mean poloidal fields, and the changes in the toroidal field by the disturbances are also seen to correspond to dynamo processes. Suitable generalizations of the equations may allow a complete dynamo cycle to take place. If so, the system would have the important computational advantage of putting all the dynamics on essentially the same time and space scales. Finally, the "magnetic modes" recently suggested by Hide to be responsible for the slow westward drift of the geomagnetic field are very unlikely to be baroclinically unstable. They could, however, be fed energy from baroclinically unstable "inertial modes." Suggestions are made for further studies of the scaled equations presented. (auth)

20844 STABILITY OF BAROCLINIC FLOWS IN A ZONAL MAGNETIC FIELD. PART I. Gilman, Peter A. (Massachusetts Inst. of Tech., Cambridge). J. Atmos. Sci., 24: 101-18 (Mar. 1967).

Because of its possible applications to the solar differential rotation, hydromagnetic dynamo theory, and the geomagnetic secular variation, the dynamics of baroclinic, geostrophic β-plane flow in a zonal (toroidal), magnetic field are studied. The equations describing the flow in the absence of a magnetic field are studied. The equations describing the flow in the absence of a magnetic field are the same as those formulated by Charney and Stern and by Pedlosky. Due to the horizontal magnetic field, potential vorticity is no longer conserved. Vertical magnetic fields can be produced, but the scaling excludes their feedback on the motions and horizontal fields. Thus, the system in its present simplest form can not complete a dynamo cycle, but suitable relaxation of some scaling restrictions may overcome this difficulty. The scaled equations are perturbed about a steady axially symmetric zonal flow and zonal (toroidal) magnetic field. Changes in the initial state are inferred from products of perturbation quantities. These include the growth in the meridional plane of axially symmetric circulations and magnetic fields (i.e., poloidal fields). The energetics of the system are examined. It is shown that the potential vorticity theorem of Charney and Stern no longer holds due to the magnetic field. For short wavelength disturbances, the field should dominate in determining the stability properties. Bounds are placed on the complex phase velocities of normal mode disturbances. For flows with vertical and horizontal shear, these are the same as found by Pedlosky for the nonmagnetic case. The bounds on growth rates of disturbances in barotropic flows are tightened by the magnetic field. Such flows will be stable to all wavelengths if the field is large enough. (auth)

20845 FIRST APPROXIMATION FOR THE FLOWS IN MAGNETOHYDRODYNAMIC SHOCK TUBES WITH EXTREMITY EFFECTS. Dragos, Lazare (Univ., Bucharest). Compt. Rend., Ser. A, 264: 202-4(Jan. 23, 1967). (In French).

In determining the first approximation for discharges in MHD shock tubes, it was stated by Nguyen-Ngoc-Tran (Comptes-rendus, 263A, pg 328, 1966) that it is evident that when $\partial\phi/2x(\sigma^-,y)$ takes any value, $\psi^1(x,y)$ has no reason to be odd in y. In order to avoid all ambiguity, the proof of the oddness of the function $\psi^1(x,y)$ for the variable y is presented. (J.F.P.)

20846 PROPAGATION OF A LAMINAR FLOW OF CONDUCTIVE-LIQUID IN A HOMOGENEOUS MAGNETIC FIELD. Dzhaugashtin, K. E. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 69-73(July-Aug. 1966). (In Russian).

The propagation of a plane laminar flow of an incompressible conductive liquid in a uniform magnetic field at Reynolds numbers much lower than one has been the object of numerous studies. The same dynamic problem is solved without linking it to the assumption of the smallness of the interaction parameter. To this end, use is made of the integral method whose application to ordinary hydrodynamics is widespread. The solution of the problem is generalized for the finite value of the Hall parameter. (ATD)

Geophysics

Refer also to abstracts 20655, 20790, and 20842-20844.

20847 (AD-642629) SEVERAL OBSERVATIONS OF LOW-ENERGY PROTONS AND ELECTRONS IN THE EARTH'S MAGNETOSPHERE WITH OGO 3. Progress Report. Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Nov. 1966. Contract Nonr-1509(06). 55p. CFSTI $3.00 cy, $0.65 mn.

An initial survey is made of low-energy electrons and protons over geocentric radial disturbances ranging from 3 to 15 RE (RE, earth radius) with measurements obtained with a sensitive electrostatic analyzer device borne on the earth-satellite OGO 3. It is intended to provide an introduction to several of the characteristics of the spatial distributions of electrons and protons over an energy range 200 to 50 keV within the earth's magnetosphere near the magnetic equatorial plane. Several features of the charged particle distributions at the boundary of durable trapping of charged particles by the geomagnetic field at geocentric radial distances approximately 8 RE in the evening sector of the earth's magnetosphere are clarified. Simultaneous observations of the differential energy spectrums of electrons and protons, separately, over the aforementioned energy range are presented for regions in the earth's magnetic tail and deep within the radiation zones and will be important providing "local" acceleration of charged particles within the earth's magnetosphere and its environs. (TAB)

20848 UNCOUPLED MAGNETO-ACOUSTIC PROPAGATION IN A DIPOLE FIELD. Radoski, Henry R. (Boston Coll., Weston, Mass.). J. Geomagnet. Geoelec., 18: 431-6(1966).

The wave equation describing the acoustic mode in a plasma magnetized by a dipole field is derived for the case in which the sound speed is much less than the Alfvén speed. The fundamental period of the first order solution is shown to be equivalent to the heuristic concept of a sound wave bouncing back and forth along a field line. This approximate solution is valid at low latitudes. The modification of the acoustic wave equation, when the gravity force is introduced, is discussed. (auth)

20849 ON THE OCCURRENCE OF LARGE SSC AMPLITUDES IN THE HORIZONTAL INTENSITY OF THE GEOMAGNETIC FIELD IN MIDDLE LATITUDES AROUND LOCAL MIDNIGHT. Srivastava, B. J. (National Geophysical Research Inst., Hyderabad, India). J. Geomagnet. Geoelec., 18: 437-42(1966).

A study is made of the SSC amplitudes in H in relation to their local time of occurrence in the middle latitudes using data of 10 geomagnetic stations for the period 1953-60. It is found that (1) the greatest SSC amplitudes in H are recorded (in the summer months) around the local midnight (1 to 3 hours before or 1 to 3 hours after the local midnight), and (2) the minimum in SSC amplitudes in H occurs (in the winter months) during 18^h-21^h L. T. at the African stations and during 4^h-10^h L. T. (generally around 7^h L. T.) at the other stations. The midnight maximum amplitude and the morning minimum amplitude are explained in terms of the ionospheric screening effect and precipitation of electrons into the auroral zone ionosphere on the night side of the earth from the outer Van Allen belt at the time of the SSC. (auth)

20850 RESULTS OF ELECTRON DENSITY MEASUREMENTS BY SOUNDING ROCKETS L-3-2 AND 3. Miyazaki, Shigeru (Ministry of Posts and Telecommunications, Tokyo). J. Geomagnet. Geoelec., 18: 481-3(1966).

Electron density profiles in the ionosphere and the exosphere were measured by means of the resonance probe method with

two Lambda rockets at the Kagoshima Space Center. On January 31, 1965, the L-3-2 rocket reached a maximum altitude of 1040 km, and the L-3-3 rocket reached its maximum altitude of 1100 km on March 18, 1965. The electron density measurements for both L-3-2 and -3 rockets were successfully performed during the entire flights. The height distributions of the electron density are shown. (J.H.M.)

20851 RELATION BETWEEN THE ^{14}C PRODUCTION RATE AND THE GEOMAGNETIC MOMENT. Wada, Masami; Inoue, Aoi (Inst. of Physical and Chemical Research, Tokyo). J. Geomagnet. Geoelec., 18: 485-8(1966).

The secular variation of the geomagnetic moment affects the intensity of primary cosmic rays and the intensity of secondary neutrons whose capture rate in the atmosphere is equivalent to the production rate of carbon-14. An investigation of the relation between carbon-14 production rate and the geomagnetic moment undertaken by Elsasser, Ney, and Winckler (1956) is based on the assumption that the spectrum of primary cosmic rays in inversely proportional to the rigidities of the particles. This note presents the relation deduced from the neutron capture rates, which were estimated by Soberman (1956) and Lingenfelter (1963). (J.H.M.)

20852 CONTRIBUTION OF COSMIC RAYS TO THE IONIZATION OF THE LOW IONOSPHERE. Velinov, P. (Geophysical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 889-92(1966).

Calculations are presented for expressing the contribution of cosmic rays to the ionization of the lowest part of the ionosphere. (J.H.M.)

20853 EFFECT OF SUPERPOSITION OF TWO EXCESSIVE SOLAR RADIATIONS IN MIDDLE IONOSPHERE. Serafimov, K.; Krivsky, L. (Geophysical Inst., Sofia. Astronomical Observatory, Ondrejov, Czechoslovakia). Compt. Rend. Acad. Bulg. Sci., 19: 893-6(1966).

Six chromospheric eruptions accompanied by an eruptive filament during the afternoon occurred on December 29, 1965, under relatively calm conditions of the sun. Ionograms were made on the day of the excessive eventa, as well as during a control period, including three days before and after the event. These ionograms were analyzed to determine the effects of solar radiation from the events on the middle of the ionosphere. (J.H.M.)

20854 LACK OF EFFECTS OF SATELLITES EUROPA, GANYMEDE, CALLISTO, AND AMALTHEA ON THE DECAMETRIC RADIO EMISSION OF JUPITER. Dulk, George A. (Univ. of Colorado, Boulder). Astrophys. J., 148: 239-48(Apr. 1967).

Examination of the decameter-wavelength radio emissions from Jupiter recorded since 1961 on the Boulder radio spectrograph shows that satellites II, III, IV, and V (Europa, Ganymede, Callisto, and Amalthea) exert no detectable influence on the probability or spectral character of the emission. This negative result implies that Io's strong influence is probably due to its large size and favorable position in Jupiter's magnetosphere. A less likely alternative is that the emission induced by satellites other than Io may be sharply beamed in directions which do not intersect the ecliptic plane and therefore the radiation is unobservable on Earth. (auth)

20855 SOLAR CAUSES OF THE OCCURRENCE OF SELECTED GEOMAGNETIC STORMS AND GEOMAGNETIC QUIET. Bednarova-Novakova, Bohumila (Geophysical Inst., Prague). Stud. Geophys. Geod., 10: 437-45(1966).

The study of solar situations preceding geomagnetic storms or geomagnetic quiet, carried out in the Geophysical Institute of the C. A. S. during one whole cycle, led to the elaboration of a new method of forecasting geomagnetic activity which can be used with the same accuracy for any period. The basis for the elaboration was a series of hypotheses which lead to the basic fact that it is important to know the coronal formation extending over the central meridian of the sun at the given moment. Since this cannot be observed directly, it is necessary to find some indirect method. One possibility is to study filaments and chromospheric structure using analogies derived from the relationships between prominences, their types and shapes and coronal formations as known from photographs of the corona, obtained during complete solar eclipses. Here the geoactivity of the filament must be defined in the following way: a filament indicates a geomagnetic disturbance, or storm, only if the coronal formation formed or being formed above it (beyond the DB) during the CMP is directed towards the earth. Since local magnetic fields play a role in the shapes of coronal formations here a further possibility would be a direct study of these fields, their changes and particularly their appearance and disappearance. However, for this one would need a very sensitive magnetograph with a high resolving power and in addition these measurements would have to be supplemented by an optical study of the chromosphere and filaments. In the present circumstances, the first method is thus more general and possibly also more exact. On the basis of many years' experience conditions were found for the origin of geomagnetic quiet and geomagnetic storms which play a role due to the effect of the local magnetic fields and the general field, which have a seemingly different effect in different periods of the solar cycle even though the cause is the same. This depends primarily on the distribution, size and density (number) of local magnetic fields. (auth)

20856 ELECTRON CONTAMINATION OF VAN ALLEN BELT PROTON MEASUREMENTS. Kuck, George A. (Air Force Cambridge Research Labs., Bedford, Mass.). Nucl. Appl., 3: 252-6 (Apr. 1967).

Short-range particles such as low-energy protons are not easily measured in the electron environment of the Van Allen belts. Some electrons scatter through large angles and deposit most of their energy in thin high-Z scintillators, causing them to be incorrectly identified as heavy charged particles. Backscattering from the high-Z material will also allow electrons to be identified as heavy charged particles. It is concluded that the high flux of trapped electrons places limitations on the use of pulse-height analysis techniques to measure low-energy protons. (auth)

20857 QUASI-HYDRODYNAMIC APPROACH TO THE PROBLEM OF SUPERSONIC PLASMA FLOW NEAR THE MAGNETIC DIPOLE. Samokhin, M. V. Magnit. Gidrodin., No. 4, 19-25 (1966). (In Russian).

The supersonic flow of rarefied plasma in the equatorial plane of a magnetic dipole is discussed. Magnetic field lines are assumed to be straight and the field intensity to be tending to the constant value in the infinity and varying inversely proportionally to the distance from the axis near the origin of coordinates. The line on which the normal velocity equals the local Alfven velocity forms a shock-wave trail, but the line on which the normal velocity component disappears—the boundary of the magnetosphere—is the forbidden zone for the straight solar plasma flow. The position of the stagnation point and the shock-wave front is defined by the Mach number as well as the characteristic dimension of the problem which is equal to the distance on which the dipole magnetic-field intensity reduces to that in the infinity, and the shock-wave asymptotes form the Mach angle with the undisturbed velocity vector. (auth)

20858 GEOMAGNETIC AND SOLAR CONTROL OF IONIZATION AT 1000 km. Chandra, S. (NASA-Goddard Space Flight Center, Greenbelt, Md.); Rangaswamy, S. J. Atmos. Terrest. Phys., 29: 259-65(Mar. 1967).

The electron density data obtained from Alouette I are examined for the individual passes to determine the geomagnetic and solar control of ionization at 1000 km. The solar zenith angle χ is chosen as a convenient solar parameter, since it implicitly includes the effect of diurnal, seasonal and latitudinal variations. The magnetic effects are studied in terms of dip angle I. It is found that plasma frequency at 1000 km varies as $\cos^2 I \cos^2 \chi/2$ in a linear way. (auth)

20859 EXCITATION AND PHOTON EMISSION RATES OF THE AURORAL NITROGEN FIRST POSITIVE GROUP. Benesch, William (Univ. of Maryland, College Park); Vanderslice, Joseph T.; Tilford, S. G. J. Atmos. Terrest. Phys., 29: 251-8 (Mar. 1967).

An examination is made of the excitation processes leading to population of the molecular nitrogen states $C^3\Pi_u$ and $B^3\Pi_g$ under auroral conditions. The conclusions are applied especially to the 1PG emission, and a number of recent measurements of auroral 1PG emission are considered in the light of the excitation rate tables of this investigation. The requirement of consistency between the measured relative photon output of the 1PG and the 2PG, and the capabilities of the possible sources of excitation for the two systems, confirm earlier conclusions that electron impingement predominates over cascading in the excitation of the auroral 1PG. Cascading from the 2PG appears to contribute from 6 to 10% to the emission from the 1PG, a somewhat lower figure than that obtained by Broadfoot and Hunten. On the basis of the auroral data considered, a tentative conclusion has been drawn that the total emission rate of the 2PG is largely independent of the auroral intensity (from IBC III to IBC IV), while there is a significant variation in the corresponding rate of the 1PG. (auth)

20860 SYNOPTIC DESCRIPTION OF THE 5577 A NIGHTGLOW NEAR 78°W LONGITUDE. Greenspan, J. A.; Woodman, J. H. (IIT Research Inst., Chicago). J. Atmos. Terrest. Phys., 29: 239-50(Mar. 1967).

The diurnal and latitudinal variations in the 5577 Å zenith

nightglow intensity are described, as observed during a ship-board expedition along the Pacific coast of South America. These results show good agreement with a similar set of data obtained in 1962. Comparison of these data with simultaneously obtained results for the 6300 Å nightglow suggest that, on a gross scale, the excitation patterns for these two emissions are unrelated. (auth)

20861 THE EFFECT OF WINDS ON THE IONOSPHERIC F2-PEAK. Rishbeth, H. (Science Research Council, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 225-38(Mar, 1967).

An approximate method is developed for computing the theoretical diurnal variation of the peak electron density, N_mF2, in the midlatitude ionosphere. It is based on the principle that the height of the F2-peak is determined by a balance between loss of ionization and plasma diffusion, this balance being modified by vertical drift. The method enables the effect of time-varying drifts on N_mF2 to be estimated. In order to verify the method, examples with zero drift are computed and give curves of N_mF2 very similar to those given by more accurate methods. The effect on N_mF2 of thermally-driven winds is then studied. The winds appropriate to sunspot maximum cause a depression of N_mF2 around midday in summer, such as is often observed, but do not account for the seasonal anomaly in N_mF2. The winds appropriate to sunspot minimum are stronger and produce effects which seem unreasonably large. At night, the winds can probably account for the maintenance of the F2 layer in summer, and perhaps in winter also. More accurate calculations are required to establish this, since it depends on the detailed behaviour of the winds near sunset. The winds are probably responsible for the day-to-night changes of the height of the peak, h_mF2, observed in midlatitudes. (auth)

20862 MAGNETOSPHERE OF JUPITER. Gledhill, J. A. (Goddard Space Flight Center, Greenbelt, Md.). Nature, 214: 155-6(Apr. 8, 1967).

The rotation of Jupiter is very rapid (36°/hour). If its magnetospheric plasma co-rotates with the planet the effect of centrifugal force on the plasma distribution will be considerable, and it may be expected that the plasma trapped in the magnetic field will be thrown out to those parts of the lines of force most remote from the axis of rotation. There is, however, a maximum plasma density which can co-rotate at a given distance from the axis. The magnetic field must be able to exert sufficient force on the plasma to provide the required centripetal acceleration. If the plasma density is too great the plasma will break away, carrying the magnetic field with it. Estimation is made of the maximum number density of the plasma in the equatorial plane, and the distribution of plasma along the lines of force. It is found that the points on the field lines farthest from the rotational axis lie nearly in a plane tilted at 7° to the equatorial plane of the planet and intersecting the latter at longitudes 100° and 280°. The effect of the centrifugal force is to confine the plasma to a discus-shaped region about the plane at 7° to the equatorial plane. As the planet rotates this discus co-rotates, and Io, the orbit of which lies in the equatorial plane, must pass obliquely through it twice every revolution. The plasma frequency in the vicinity of Io will rise to a maximum and fall again during each such passage. It is assumed that mechanisms exist which allow the generation by Io of radio waves at or near the plasma frequency. A model is presented for Jupiter's magnetosphere in which the maximum plasma frequency is directly controlled by the magnetic field. A possible source of radio noise, not related to Io, is mentioned. (UK)

20863 STIMULATION OF JUPITER'S RADIO EMISSION BY Io. Marshall, L. (Univ. of Colorado, Boulder); Libby, W. F. Nature, 214: 126-8(Apr. 8, 1967).

Variations in the decameter radio signals from Jupiter are known to be associated with one of the planet's five satellites. It is suggested that Io travels in the analogue of the inner Van Allen radiation belt surrounding Jupiter, giving rise to a plasma wake which streams ahead of it by about 130,000 km, and stimulates the radio emission from the Jovian atmosphere. (UK)

20864 CHARGED-PARTICLE TEMPERATURES AND ELECTRON THERMAL CONDUCTIVITY IN THE UPPER ATMOSPHERE. Banks, Peter M. (Institut d'Aeronomie Spatiale de Belgique, Brussels). Ann. Geophys., 22: 577-87(Oct.-Dec. 1966).

Measurements of electron and ion temperatures in the ionosphere which have involved satellite, rocket, and ground based techniques have shown that throughout the day and during much of the night there exist considerable differences between the temperatures of the charged and neutral gases. The results above 150 km indicate that photoionization is the principal source of heating in the daytime electron gas. The problem of calculating theoretical values of electron and ion temperatures in the upper atmosphere is discussed. Thermal conductivity of the electron gas is important in determining the profiles of electron and ion temperatures in the upper atmosphere. Previous calculations have been based upon the thermal conductivity derived for a fully ionized gas. In aeronomic conditions, however, the contribution made by neutral gas particles must be introduced. An analysis is made of the effect of electron–neutral particle collisions and an expression is developed for the electron thermal conductivity which is applicable to a weakly ionized plasma. It was found that a correction term needed to include the effect of neutral particles is important during both day and night at all altitudes below 220 km. At altitudes below 135 km the conduction term can be neglected in the electron energy balance equation. Using the derived expression for the effective electron thermal conductivity, an example of calculated temperatures characteristic of quiet solar conditions is presented. (BBB)

20865 IONOSPHERIC SUN ERUPTION OBSERVATION (SUDDEN IONOSPHERIC DISTURBANCE) AT THE COLLM GEOPHYSICAL OBSERVATORY. Schminder, Rudolf (Karl-Marx-Univ., Leipzig). Wiss. Z. Karl-Marx-Univ., Leipzig, Math.-Naturwiss. Reihe, 13: 411-13(1964). (In German).

Between 1959 and 1962 a rigid correlation (r = 0.90) between the number of observed sudden ionospheric disturbances (SID) and the sunspot relative number R was observed. The frequency distribution of the SID indicated by this correlation overlay a yearly double wave with maxima in the equinox with its origin in the annual variation of the geometric location relation between sun and earth. The frequency of corpuscular-caused geomagnetic or ionospheric perturbations can be correlated, frequently dependent on the type of release of the perturbation in the ionosphere or in the area of the radiation belt, rigidly with the variation of R or with the annual variation of the location relation between sun and earth. (tr-auth).

20866 EFFECT OF SOLAR COSMIC RAYS ON LOW IONOSPHERE. Nestorov, G.; Velinov, P. (Geophysical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 1011-14(1966).

On May 4, 1960, after a solar chromospheric eruption, there arose a flux of solar cosmic rays. This event was characterized not only by a considerable increase of the different components of cosmic rays, but also by a complex of geophysical effects, one of which was the anomalous increase of ionospheric absorption. It was recorded in Sofia at 164 kc and was the subject of a special study. There the main qualitative processes which occurred on May 4 were explained on the basis of ionospheric, radioastronomical, and cosmic data. A quantitative analysis is given which is aimed at revealing the effect of solar protons through the lower atmosphere, as well as their contribution to the additional ionization in the D region. (W.D.M.)

20867 INVESTIGATION OF CORPUSCULAR RADIATION BY THE LUNA-10 ARTIFICIAL SATELLITE. Grigorov, N. L.; Maduev, V. L.; Mandel'shtam, S. L.; Pisarenko, N. F.; Savenko, I. A.; Tindo, I. P. (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 170: 567-9(Sept. 21, 1966). (In Russian).

Gas-discharge counters (types SBT-9 and SF) were carried on the surface of Luna-10. The SBT-9 had a window 0.2 cm^2 in area made of a 1.2-mg/cm^2 layer of mica covered by 0.3-mg/cm^2 gold sheet to decrease its registration effectiveness for solar x rays with wavelengths shorter than 10 Å. This counter registered electrons and protons with energies greater than 40 keV and 0.5 MeV, respectively. The SF counter windows were aluminum sheets 2.7 mg/cm^2 thick and 0.5 cm^2 in area. These registered x rays with wavelengths shorter than 14 Å, and electrons and protons with energies greater than 50 keV and 800 keV, respectively. The pulses from all counters were registered on logarithmic scales. The SF counter data were registered by independent logarithmic integrators. The telemetry system sampled the channels once every two minutes. The SBT-9 counter rate output increased in the first part of April, owing to x radiation from the Sun. The SF counters were switched on April 8. The satellite crossed the assumed boundary of the earth's magnetospheric tail four times. During these periods all counters simultaneously indicated an increased activity. The maximum count in the period between May 2 and 5 was 50 pulses · cm^{-2} · sec^{-1} · sterad for the SBT-9 counter and 40 pulses · cm^{-2} · sec^{-1} · sterad for the SF counters. This activity is assumed to be due to unidirectionally moving electrons in the magnetosphere region whose energies exceed 40 keV. The data indicate that the earth's magnetospheric tail is 60° wide and that the magnetic field does not form closed lines around the moon. (ATD)

20868 EXPERIMENTAL RESULTS FROM OBSERVATIONS OF THE LUNAR IONOSPHERE PERFORMED WITH THE FIRST ARTIFICIAL LUNAR SATELLITE. Gringauz, K. I.; Bezrukikh, V. V.; Khokhlov, M. Z.; Zastenker, G. N.; Remizov, A. P.; Musatov, L. S. Dokl. Akad. Nauk SSSR, 170: 1306-9(1966). (In Russian).

In previous article on the Luna-10, a brief description was given of the two low-energy ion and electron traps that were carried by the satellite. K. I. Gringauz et al., published a preliminary analysis of the data from these traps, and made some tentative deductions concerning the nature of the lunar ionosphere. One difficulty in the trap measurements was the generally low concentration of charged particles in the lunar ionosphere. Another is the uncertainty as to what effect the unknown surface charge status of the satellite might have on the registered particle levels. It was to counter the latter effect that traps for both thermal ions and thermal electrons were installed, each with a form of square-wave gating. The ion trap had twin orthogonal elements and a common collector. Output was detected by an amplifier tuned to the modulation frequency. To further overcome spurious local charge effects, the outermost grid was also modulated at 2-minute intervals by a square wave between 0 and −50 V. The electron trap outer grid was similarly modulated, but between 0 and +50 V. Interrogation of the traps was performed at 2-minute intervals. It was pointed out that rotation or tumbling of the satellite, with a period of about 40 seconds, caused "irregularity" in the measurements; this point was not elaborated on. Data from the ion trap provided some idea of ion distribution in the vicinity of the moon, but do not yield a breakdown between thermal and possibly higher energy ions. Calculated ion currents from some 450 readings are shown as a function of altitude, for the general cases where the moon was (1) within and (2) outside of the earth's magnetosphere. A perceptible drop in ion current is seen when the moon and its satellite entered the magnetosphere—on the average, from 3.1×10^{-12} amp to 2.3×10^{-12} amp. It also appears that there is no strong correlation of ion density with lunar altitude, nor with change in bias of the trap's external grid. It is is assumed that the ions encountered were thermal, i.e., that the satellite's orbital velocity greatly exceeded ion thermal velocities, then the calculations show a maximum ion density near the moon of about $100/cm^3$. However, a varying component of ion flux was noted which could be correlated with solar wind flux; this fact, plus the nondependence of measured flux on altitude or grid biasing, suggest that at least part of the recorded ions were at energies well above thermal, in which case the ion density estimate would have to be revised downward. The satellite's electron count, both in free space and in the magnetosphere, showed discrete high and low levels. (ATD)

20869 INDICATIONS THAT THE MOON TRAVERSES THE EARTH'S MAGNETOSPHERE TAIL, ACCORDING TO DATA FROM CHARGED-PARTICLE TRAPS PLACED ON THE FIRST ARTIFICIAL LUNAR SATELLITE. Gringauz, K. I.; Bezrukikh, V. V.; Khokhlov, M. Z.; Musatov, L. S.; Remizov, A. P. Dokl. Akad. Nauk SSSR, 170: 570-3(Sept. 21, 1966). (In Russian).

Luna-10 carried two flat four-electrode charged-particle traps which monitored the flux intensity of electrons with energies exceeding 70 eV and positive ions with energies greater than a quantity determined by the second grid voltage, which was varied from 0 to +50 V once every two minutes. During the measurement sessions, the trajectory of the moon and its artificial satellite was such that it crossed the boundaries of the earth's magnetosphere. During this time the measured difference of electron ($E < e > 70$ eV) and positive ion ($Ep > 50$ eV) flux was negative inside and positive outside the assumed boundary of the magnetosphere. Solar activity was normal during these measurements. If the above criterion is valid for defining the magnetosphere boundary, then the Luna-10 data indicate that the magnetosphere tail extends at least 380,000 km from the earth. (ATD)

20870 MEASUREMENT OF THE MAGNETIC FIELD IN THE VICINITY OF THE MOON BY THE LUNA-10 ARTIFICIAL SATELLITE. Dolginov, Sh. Sh.; Eroshenko, E. G.; Zhuzgov, L. N.; Pushkov, N. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radiowave Propagation, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 170: 574-7(Sept. 21, 1966). (In Russian).

The magnetic field intensity in the vicinity of the moon was measured by a three-component magnetometer carried on Luna-10. The magnetometer measurement range and its threshold of sensitivity in each direction were 50 γ (1 $\gamma = 10^{-5}$ Oe) and 1 γ, respectively. During the lunar orbital flight the satellite rotated around a given axis. The magnetic field components parallel ($T_{||}$) and perpendicular ($T_{\perp}$) to this axis were measured. The absolute and relative errors in measuring the resultant magnetic field were estimated to be ±10 γ and ±5 γ, respectively. During the observation period (April 3 to May 4, 1966), the total magnetic field and its components fluctuated in the following ranges: $T = 23-40\ \gamma$, $T_{||} = 18-38\ \gamma$, and $T_{\perp} = 12-16\ \gamma$. A correlation was established between variations in T and $T_{||}$ and changes in the magnetic activity index. It was not possible to establish the presence of a lunar dipole magnetic field or the earth's magnetospheric tail by means of these direct observation methods. The most reliable average value of $T_{\perp}$ obtained was 15 γ, which exceeds the interplanetary value for the same index of magnetic activity. It is hypothesized that the moon is magnetically permeable. (ATD)

20871 ANOMALY IN THE COMPOSITION OF GENERATED IONS AND CERTAIN PHENOMENA IN THE LOWER IONOSPHERE. Ivanov-Kholodnyi, G. S. Dokl. Akad. Nauk SSSR, 170: 831-4(Oct. 1, 1966). (In Russian).

An analysis was made of the rate of formation of $[NO^+]$ and $[O_2^+]$ ions and the effective coefficient of ion recombination α' in the lower atmosphere at altitudes ranging from 100 to 200 km. By analyzing the previous data on the M-20 computer, it was established that the ratio $[NO^+]/[O_2^+]$ decreases with decreasing altitude (in the range between 200 and 150 km) and increasing zenith angle (in the range 60 to 90°). The increasing solar activity causes the $[NO^+]/[O_2^+]$ ratio to increase, but its variation with altitude and the zenith angle becomes less pronounced. However, at altitudes below 150 km the ratio $[NO^+]/[O_2^+]$ increases with increasing zenith angle and decreasing solar activity. By analyzing the most reliable mass spectrometer data, it was established that the variation of α' as a function of the solar activity, altitude, and the zenith angle is opposite to the variation of $[NO^+]/[O_2^+]$. (ATD)

20872 OBSERVING THE ULTRALOW-FREQUENCY RADIATION FROM TWO CONJUGATE POINTS. Kleimenova, N. G.; Troitskaya, V. A.; Zhandren, R.; Ponso, K.; Vineron, Zh. (Shmidt Inst. of Physics of the Earth, Academy of Sciences, USSR. Central Inst. of Telecommunications, Paris). Dokl. Akad. Nauk SSSR, 170: 835-6(Oct. 1, 1966). (In Russian).

Joint French–Soviet investigation of ultralow-frequency radiation in the 1.5- to 3-kc range was conducted from July, 1964, to March, 1965, at two stations (Sorga in the Soviet Union and Kerguelen in the Indian Ocean). The radiation was continuously monitored on paper track recorders. The simultaneously recorded data indicate that whistler atmospherics seldom occur at the same time at both stations, whereas the occurrence of hissing static activity (recorded 38 times) and its strength were correlated at both stations. In all of the observed instances (11 times) the increased whistler atmospherics activity gave a 14 to 18 hr forewarning of an impending negative ionospheric storm. The positive ionospheric storms however were never detected by monitoring the activity of hissing static and whistler atmospherics. From other observations it was established that the conditions for the generation of ulf radiation in the exosphere are nonexistent during magnetically quiet periods when the boundary of the earth's magnetosphere extends to approximately $10R_e$ where R_e is the earth's radius. (ATD)

20873 DELAYED EFFECTS OF SUDDEN IONOSPHERIC DISTURBANCES ON 164 kc/s TRANSMISSION BETWEEN TASHKENT AND AHMEDABAD. Ananthakrishnan, S.; Ramanathan, K. R. (Physical Research Lab., Ahmedabad, India). Proc. Indian Acad. Sci., Sect. A, 65: 38-44(Jan. 1967).

Continuous recording of the field strength of 164-kc CW transmission from Tashkent (42° N, 69° E) has been going on at Ahmedabad (23° 01′ N, 72° 36′ E) since March 1960. The present communication deals with a delayed effect of SID's which has been observed on the 164-kc transmissions. (auth)

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Refer also to abstracts 20517 and 20736.

20874 (BNL–9779) NOTE ON THE FREE ENERGY OF SUPERCONDUCTING SYSTEMS. Schweitzer, Donald G. (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 3p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

One of several independent arguments is presented which show that the isothermal free energy change along a number of different types of reversible paths in superconducting systems may be only a function of the external magnetic field, independent of the internal field and the magnetization per unit volume. It is shown that the free energy change with external magnetic field on a reversible path in any type of superconductor (type-I, type-II, and hysteretic) is monotonic. (M.H.R.)

20875 (CEA-R–3149) TRANSITION SUPRACONDUCTRICE ET MAGNETORESISTANCE EN CHAMP FAIBLE D'UN ECHANTILLON MONOCRISTALLIN DE NIOBIUM A 4,2°K. (Superconducting Transition and Low-Field Magnetoresistance of a Niobium Single Crystal at 4,2°K). Perriot, Gaston (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1967. 60p. (In French). Dep. mn.

The study of the electrical resistance of a niobium single crystal at 4.2°K, from the beginning of the superconducting transition to 80 kilooersteds is reported. Critical fields H_{c2} and H_{c3} have been determined. Influences on superconducting transition of current

density, field–current angle, crystal orientation, and magnetoresistance have been studied. Variation laws of low-field transverse and longitudinal magnetoresistances have been determined. (tr-auth)

20876 (IAE–1208) KRITERII STABIL'NOSTI TOKA V KOMBINIROVANNYKH (NORMAL'NYKH + SVERKHPROVODYASHCHIKH) PROVODNIKAKH. (Criteria for Current Stability in Combined (Normal + Superconducting) Conductors). Keilin, V. E.; Klimenko, E. Yu.; Kremlev, M. G.; Samoilov, B. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 12p. (In Russian). Dep. mn.

The method of Kantrovitz and Stekly for stabilizing the superconducting-to-normal state transitions of superconducting solenoids prompted a development of large-scale magnetic systems, but the stability relative to thermal perturbations remained unclear. Consequently, a theoretical study of the heat conduction equation for a model consisting of an infinite one-dimensional conductor made of normal and superconducting metals in good mutual thermal and electrical contact was carried out. A specified non-zero temperature derivative at the origin is established by a thermal point source at the origin. Stability conditions for such a model are obtained for supercritical and subcritical currents. Some deviations of the preliminary experimental results from those predicted by the theoretical model are discussed. Additional stability is probably due to the nonlinear and hysteresis-exhibiting heat production during liquid helium boiling and to the influence of the surface resistance between normal and superconducting metals. Both these effects require further study since they may significantly affect the stability of combined superconductors. (JPRS)

20877 (ORO–2570-11) INFLUENCE OF IMPERFECTIONS AND INTERSTITIAL CONTAMINANTS ON THE MECHANICAL PROPERTIES AND SUPERCONDUCTING BEHAVIOR OF METALS. Progress Report, February 1, 1966–February 1, 1967. Daniels, R. D.; Haden, C. R. (Oklahoma Univ., Norman. Coll. of Engineering). Contract AT(40-1)-2570. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The influence of interstitial contaminants and processing variables on the low-temperature deformation and fracture behavior of metals was studied previously. The study was broadened to include the effects of structure, processing, and impurities on the superconducting behavior of metals. The work thus far has been directed into design and construction of the microwave experiment. Other efforts were made on initial calibration experiments and surface preparation samples. An extensive literature survey was made. (M.H.R.)

20878 (UCRL–16422) REVERSIBLE PHASE TRANSITION OF A TYPE-II SUPERCONDUCTOR INDUCED BY CRITICAL EDDY CURRENTS. Boyd, R. G. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1965. Contract W-7405-eng-48. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An attempt is made to show that the transitions were caused by the generation of critical eddy currents in the specimen by the rapidly pulsed magnetic field, using a hollow cylinder. (M.H.R.)

20879 CERTAIN EFFECTS DUE TO DIAMAGNETISM OF THE WINDING OF A SUPERCONDUCTING SOLENOID. Ternovskii, F. F. (Moscow State Univ. Scientific Research Inst. of High Temperatures, Moscow). Dokl. Akad. Nauk SSSR, 171: 1084-7(Dec. 11, 1966). (In Russian).

The purpose of the investigation was to ascertain what information concerning the properties of hard superconductors can be extracted from inductance measurements, since experiments have shown that the inductance of a superconductor depends greatly on the current flowing in it and on the external magnetic field. The properties of a superconducting solenoid are analyzed by using the dependence of the magnetic flux linking the turns of the solenoid on the current. The flux in turn is separated into external and internal components, with particular attention paid to the effect of the internal component, whose filamentary nature (quantum vortices) results in nonuniform magnetization, owing to the interaction between the quantum vortices and inhomogeneities in the superconducting material. An expression for the internal flux is derived under certain assumptions concerning the distribution of the induction inside the solenoid, and a table of numerical values for the coefficients of this expression is presented. This leads to an expression for the inductance of the superconducting solenoid in the form of two components: external inductance, which is almost independent of the current, and internal inductance which depends both on the current and on the magnetic history of the solenoid. It is pointed out that usual impedance measurements give only the external inductance. It is noted that recent measurements of the internal flux in the superconductor agree with the approximate calculations presented in the paper. (ATD)

20880 EFFECT OF ROTATION ON THE DIELECTRIC CONSTANT OF ROTATING HELIUM. Andelin, John (Ford Scientific Lab., Newport Beach, Calif.). Phys. Rev. Lett., 18: 483-4 (Mar. 27, 1967).

The dielectric constant of He II has been found, experimentally, to be independent of rotation to 1 part in 10^7, the sensitivity of the measurement, for angular rotation rates up to 12 rad/sec between 1.4 and 2.15°K. (auth)

20881 HELICON MODES IN PURE TYPE-II SUPERCONDUCTORS IN THE HIGH-FIELD REGION. Caroli, Christiane; Maki, Kazumi (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 18: 698-700(Apr. 24, 1967).

Maxfield and Johnson (Phys. Rev. Letters, 16: 652(1966)) reported an obervation of helicon-like resonances in pure Nb in the mixed state. Theoretical considerations relating to this phenomenon are presented by the authors of this letter. (J.H.M.)

20882 EFFECT OF DEFORMATION ON SUPERCONDUCTIVITY CHARACTERISTICS OF NIOBIUM AND VANADIUM. Sirota, N. N.; Ovseichuk, E. A.; Stribuk, E. K. (Inst. of the Physics of Solids and Semiconductors, Minsk). Dokl. Akad. Nauk SSSR, 171: 88-90(Nov. 1, 1966). (In Russian).

Niobium and vanadium specimens (3 × 17 × 0.6 mm), annealed at 1100°C for 6 hr and furnace cooled, were cold rolled with 23, 29, 43, 52, 74 and 92% reduction (vanadium) or 38, 57, 70 and 78% reduction (niobium). It was found that the electrical conductivity and critical magnetic field increase linearly with increased reduction in rolling. For example, the intensity of the critical magnetic field at 4.2K, 1050 Oe for annealed vanadium and 5000 Oe for annealed niobium, increased to 1320 Oe for vanadium rolled with 52% reduction and to 6300 Oe for niobium rolled with 57% reduction. The critical temperature of transition to the superconducting state was not affected by deformation. It was concluded that the critical current density and critical magnetic field can be substantially increased by cold deformation of superconductors which have high temperatures of recovery and recrystallization. (ATD)

20883 ELECTRICAL RESISTANCE AND MAGNETIZATION OF TYPE-II SUPERCONDUCTORS. Rayroux, J. M.; Itschner, D.; Mueller, P. Phys. Lett., 24A: 351-2(Mar. 27, 1967).

The voltage U across a type-II superconductor under constant transport current and linear field sweep conditions is shown to be proportional to BdB/dt. The relation of U to the magnetization and the ac losses is pointed out. (auth)

20884 MICROWAVE INVESTIGATION OF THE SMALL GAP ANOMALY IN LANTHANUM. Thompson, W. A. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Lett., 24A: 353-4(Mar. 27, 1967).

It is shown that in fcc lanthanum the measured ratio of superconducting energy gap to transition temperature strongly depends on annealing treatment. (auth)

20885 ANOMALOUS ELECTROMAGNETIC MICROWAVE ABSORPTION OF SUPERCONDUCTING ALLOYS IN A STATIC MAGNETIC FIELD. Bennemann, K. H. (Univ. of Chicago). Phys. Lett., 24A: 357-8(Mar. 27, 1967).

The microwave surface-resistance anomaly of impure superconducting Al in a static magnetic field is qualitatively explained. The relation between surface superconductivity and surface resistance is also discussed. (auth)

20886 SUPERCONDUCTING ENERGY GAP OF BULK LANTHANUM BY POINT-CONTACT TUNNELING. Levinstein, H. J.; Chirba, V. G.; Kunzler, J. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Lett., 24A: 362-4(Mar. 27, 1967).

The superconducting energy gaps of both cubic and hexagonal lanthanum, obtained by point-contact tunneling to bulk samples, are reported. The values are somewhat higher than predicted by BCS theory as is typical of strong-coupling superconductors. (auth)

20887 THERMALLY INDUCED VOLTAGES IN THE MIXED STATE OF TYPE-II SUPERCONDUCTORS. Lowell, J.; Munoz, J. S.; Sousa, J. (Oxford Univ.). Phys. Lett., 24A: 376-7 (Mar. 27, 1967).

Voltages resulting from the application of temperature gradients to a type-II superconductor behave in a manner consistent with the moving-flux model. (auth)

20888 SUPERCONDUCTIVITY AND ISOTOPE EFFECT IN $Be_{22}X$ COMPOUNDS AND MOLYBDENUM. Bucher, E. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Palmy, C. Phys. Lett., 24A: 340-1(Mar. 27, 1967).

The transition temperatures of Be_{22} X compounds are found

to be much higher for X = W, Re than for X = Mo, Tc. The isotope effect in Be_{22} Mo gives evidence of a stronger coupling to the Mo-localized mode than to the beryllium mode. (auth)

20889 ON ANOMALOUS VALUES OF H_{c3}. Rothwarf, A. (Radio Corp. of America, Princeton, N. J.). Phys. Lett., 24A: 343-4(Mar. 27, 1967).

The nucleation of superconductivity within small irregularities ($R \sim \xi$) on the surface of bulk samples is suggested as a possible cause of anomalously high values of H_{c3}. An estimate of the magnitude H_{c3} and its size and temperature dependence are obtained from the Ginzburg–Landau equation. (auth)

20890 COLLECTIVE MODES IN TYPE-II SUPERCONDUCTORS. Druyvesteyn, W. F. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett., 24A: 415-16(Apr. 10, 1967).

EM waves with $k \perp H_0$ in type-II superconductors are discussed. Propagation is only possible when large Hall angles are present. For smaller Hall angles the (imaginary) ratio between ω and k^2 is determined by the elastic constants of the flux line lattice. (auth)

20891 ELECTRON AND PHONON EFFECTS IN SUPERCONDUCTING FCC LEAD-BASED ALLOYS. Adler, J. G.; Jackson, J. E.; Will, T. A. (Case Inst. of Tech., Cleveland. Western Reserve Univ., Cleveland). Phys. Lett., 24A: 407-9(Apr. 10, 1967).

Electron tunneling measurements in fcc alloys of Pb with Bi, Tl, and In (over the range from 4.1 to 3.3 electrons/atom) are reported, and these measurements are related to the phonon spectrum and electron–phonon interaction. The tunnel junctions were prepared by standard techniques and the experiments were carried out below 1°K. (W.D.M.)

20892 PERSISTENT SUPERFLUID FLOW IN A CIRCUIT FILLED WITH JEWELLER'S ROUGE. Van Alphen, W. M.; De Bruyn Ouboter, R.; Taconis, K. W. (Kamerlingh Onnes Lab., Leiden). Phys. Lett., 24A: 380-1(Mar. 27, 1967).

A persistent superfluid flow in a twofold connected circuit of compressed jeweller's rouge has been created and observed. The angular momentum and circulation have been investigated as a function of temperature. (auth)

20893 INFINITE RANGE CORRELATION AND LARGE EIGENVALUES OF THE 2-MATRIX. Coleman, A. J. (Queen's Univ., Kingston, Ont.). Can. J. Phys., 45: 1271-3(Mar. 1967).

A simple energy argument indicates that the existence of an eigenvalue of order N^{-1} in the second-order reduced density matrix, or 2-matrix, implies macroscopic correlation characterized by the corresponding eigengeminal. (auth)

20894 RELATIONSHIP BETWEEN THE SPIN SUSCEPTIBILITY ENHANCEMENT AND THE SUPERCONDUCTING TRANSITION TEMPERATURE. Jensen, M. Anthony (Univ. of Pennsylvania, Philadelphia); Andres, K. J. Appl. Phys., 38: 1255-7 (Mar. 1, 1967).

The observed relationship between the magnetic spin susceptibility and the superconducting transition temperature for the fcc transition metals is analyzed in terms of the recent theory of Berk and Schrieffer for the effect of spin fluctuations on the pairing interaction. The results indicate that the decrease in the transition temperature and the increase in the susceptibility are intimately connected and are both basically caused by an increasing Coulomb repulsion. The band density of states is found to decrease on going from iridium to rhodium, platinum, and palladium in qualitative agreement with recent x-ray-emission spectroscopy results of Claus and Ulmer. The theory allows one to estimate the size of the spin susceptibility in the superconducting alloys to within about 5%, from which one concludes that the decrease in the transition temperature past iridium should be even more rapid than is actually observed. (auth)

20895 BASIC PROPERTIES OF 65BT-TYPE SUPERCONDUCTING ALLOY WIRE IN SPECIMENS AND SOLENOIDS. Alekseevskii, N. E.; Dubrovin, A. V.; Mikhailov, N. N.; Sokolov, V. I.; Fedotov, L. N. (Central Scientific Research Inst. of Ferrous Metallurgy, Moscow). Dokl. Akad. Nauk SSSR, 171: 566-9(Nov. 21, 1966). (In Russian).

A method of protecting superconductors from damage during the transition from superconducting to normal state has been developed. The 65BT superconducting niobium–titanium alloy wire (65% niobium and some zirconium) was developed by the Institute of Precision Alloys at the Central Scientific Research Institute of Ferrous Metallurgy. At 293, 77, and 20°K the wire has a tensile strength of 81, 140, and 192 kg/mm^2, a notch toughness of 18.5, 5.8, and 4.4 kg/cm^2, and a resistivity of 70, 59, and 56×10^{-6} ohm · cm, respectively. The critical temperature of the wire is 9.7°K and the critical magnetic field at 4.2°K is 90 kOe. It was found that a thin copper coating effectively prevents wire damage during the transition from the superconducting to the normal state. Wire 0.25 mm in diameter was coated with a layer of copper, 10 to 20 μ thick, and used for solenoids with field intensities of 19 and 54 kOe. The solenoids withstood long periods of operation and proved to be stable and reliable. They were used in studying galvanomagnetic properties of pure metals in semiconductors, in investigating the critical parameters of superconducting materials, etc. (ATD)

20896 ELECTROMAGNETIC PERFORMANCE OF Nb_3Sn VAPOR-DEPOSITED RIBBON UP TO 200 KILOGAUSS. Schindler, H. C. (Radio Corp. of America, Harrison, N. J.). RCA Eng., 12: 29-31(Dec. 1966–Jan. 1967).

The relative stability and overall electromagnetic performance of Nb_3Sn ribbon in high-field magnets is described. With knowledge of the relation between the volume of Nb_3Sn layers and stability, ribbons can be designed and selected for use in magnetic fields up to 200 kG. Experiments in superconductivity were performed in liquid helium, the boiling point of which (4.2°K) is lower than the critical temperature of the Nb_3Sn superconductor. The variation of critical current as a function of transverse-background field at 4.2°K is shown for a typical 2.5×10^{-4}-in. layer of Nb_3Sn on a 0.090×0.0018-in. metallic substrate. The electromagnetic performance of vapor-deposited Nb_3Sn on metallic substrates at high fields is outlined, and the stability of different types of Nb_3Sn deposits are described. It is possible to design ribbon for use in magnets up to 160 kG with a single current level. For higher field magnets, up to the 180-kG or the 190-kG range, multipowered magnet systems are required. At the present stage of development, magnets of the 150- to 180-kG class are about the highest fields that can be practically achieved with Nb_3Sn at liquid He temperatures. The reduction of the vapor pressure of He by mechanical evacuation lowers its temperature. If the temperature is below the lambda point, the field region can be raised another 20 to 30 kG thus permitting the design of 200-kG magnets. (BBB)

20897 INFLUENCE OF DIELECTRIC FILMS ON THE SUPERCONDUCTIVITY OF THIN Sn AND Tl FILMS. Hilsch, P.; Naugle, D. G. (Univ., Goettingen, Ger.). Z. Phys., 201: 1-9(1967).

The change in transition temperature for thin Sn and Tl films was measured after deposition of dielectric substances. The change in transition temperature is inversely proportional to the thickness of the superconducting film and relatively independent of the thickness of the dielectric film. When SnS or Tl_2Se is deposited on Sn films, the transition temperature is depressed. When TlCl or Tl_2Se is deposited on Tl films, the transition temperature is increased. When S is deposited on Tl films, there is no initial change in T_c; however, T_c is appreciably increased after annealing. A possible explanation for this effect is the reduction of the free electron concentration in the metal through the formation of the contact potential between the dielectric and the metal. (auth)

20898 CRITICAL CURRENTS IN TWISTED SUPERCONDUCTING NIOBIUM–ZIRCONIUM WIRES. Voigt, H. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Z. Angew. Phys., 22: 53-5(1967). (In German).

The critical current of superconducting Nb–Zr wires was found to be enhanced by twisting the wires. A wire with a critical current of 160 A was able to carry 260 A without quenching if it had been twisted. The critical current rose by the degree of twisting. In transverse magnetic fields (up to 50 kOe) the critical current of twisted wires was also larger than that of nontwisted wires. Measurements in longitudinal fields give information on the source of the effect. (auth)

20899 THE CRITICAL TEMPERATURE OF SOME COLD WORKED AND HEAT TREATED Nb–75 PERCENT Zr WIRE SAMPLES. Ruzicka, Jiri (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez); Plechacek, Vladimir. Cesk. Cas. Fys., 17: 142-8(1967). (In Czech).

A cryostat for the critical temperature measurement of superconducting samples up to 20°K with an accuracy of ±0.02° is described. The niobium–75 wt % zirconium wire samples with combined mechanical and heat treatment were measured in this cryostat and the results of the measurements are given. The critical temperature of heat-treated samples with a following high degree of cold working is practically independent of the annealing temperature. Those samples which were first cold worked up to the final diameter and then heat treated indicate a strong dependence on the annealing temperature. (auth)

20900 PARAMETRIC AMPLIFICATION OF MICROWAVES IN SUPERCONDUCTING JOSEPHSON TUNNEL JUNCTIONS. Zimmer, H. (Philips Zentrallaboratorium GmbH, Hamburg). Appl. Phys. Lett., 10: 193-5(Apr. 1, 1967).

A dielectric open resonator of polycrystalline rutile with a thin layer of about 500-Å thickness evaporated on one face was mounted in a waveguide with a movable plunger. The device

was operated in the doubly degenerate mode, and pump and signal power were applied within the resonance band of the rutile resonator at 9646 MHz. The idler signal appeared at a temperature below the transition temperature of tin; simultaneously the signal power was amplified and the reflected pump power was decreased. These results are discussed. (M.O.W.)

20901 SUPERCONDUCTIVE ELECTROMAGNETS FOR WEAK MAGNETIC FIELDS. Dolezal, Ivan (Czech Technical Univ., Prague); Svec, Karel; Votruba, Jan. Cesk. Cas. Fys., 17: 154-7(1967). (In Czech).

Two superconducting electromagnets are described. The first is a closed Bitter-type one for obtaining magnetic fields up to 16 kOe, the second was designed as a control element of the motion mechanisms in space with a very low temperature. A description is given of a simple laboratory technic of the production of a superconducting wire from eutectic Pb–Bi. (auth)

20902 COMPUTER CALCULATIONS FOR THE DESIGN OF LARGE HIGH-FIELD SUPERCONDUCTIVE MAGNETS. Thompson, P. A. (Radio Corp. of America, Harrison, N. J.). RCA Eng., 12: 14-18(Dec. 1966-Jan. 1967).

Design calculations for superconductive magnets carried out on the RCA 601 computer are discussed, as well as the general topic of magnetic calculations and the mathematical bases for the specific calculations employed. Special emphasis is placed on complex problems involved in designing large, high-field superconductive magnets. For magnetic systems wound with superconductors, there is a unique combination of maximum current density and local field at the conductor for any operating temperature (usually 4.2°K). This situation underscores the importance of having a computer code which can reliably calculate the field values within the actual winding volume. For any proposed design, the highest field in the windings must be checked against the critical current density vs the local field value to see if the necessary working current is possible. The basic codes, adapted from earlier work and programmed from original sources, have concentrated on the calculation of the electromagnetic fields, the forces, and the inductance of the magnet system once the design had been made. Later, coding was directed toward automatic design from specified geometry, field, and homogeneity requirements, all within the empirically derived characteristics of the superconductor to be used. Also, special purpose and one-time codes were written as the occasion demanded. More work is being done on automatic design codes, with an immediate goal being the Garrett 6th-Order Coil configurations. (BBB)

20903 PARAMETERS OF PHENOMENOLOGICAL SUPERFLUIDITY THEORY AND THE λ POINT SHIFT. Mamaladze, Yu. G. (Inst. of Physics, Tbilisi, USSR). Zh. Eksp. Teor. Fiz., 52: 728-31(Mar. 1967). (In Russian).

Some new empirical expressions for the parameters of the phenomenological theory of superfluidity are derived. Their temperature dependence is different from that previously assumed and as a result the formula for the λ point shift in narrow gaps and rotating helium must be modified. (auth)

20904 INFLUENCE OF FERMI SURFACE SHAPE ON FROELICH'S QUASI-SUPERCONDUCTIVE TRANSITION. Bate, R. T. (Texas Instruments, Inc., Dallas). Proc. Phys. Soc. (London), 90: 876-7(Mar. 1967).

It is pointed out that the minimum magnetic field for the quasi-superconductive transition predicted by Fröhlich can be reduced by taking advantage of Fermi surface anisotropy in uniaxial crystals. (auth)

20905 ELECTRON TUNNELING INTO SUPERCONDUCTING LEAD–THALLIUM ALLOYS. Claeson, T. (Chalmers Univ. of Tech., Goteborg). Solid State Commun., 5: 119-22(Feb. 1967).

Phonon structure in Pb–Tl has been observed by electron tunnelling. A shift to higher phonon energies was registered for a $Pb_{0.4}Tl_{0.6}$ alloy compared with pure Pb. The electron–phonon coupling decreases with increasing Tl concentration. The results agree with neutron-diffraction data and with previous T_c measurements. (auth)

20906 EFFECTS OF THE d-ELECTRON CORRELATION ON THE TRANSITION TEMPERATURE OF AN ANISOTROPIC IMPURE SUPERCONDUCTOR WITH RESONANCE SCATTERING. Nagashima, Tomitaro; Soda, Toshio (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto), 36: 1299-1300(Dec. 1966).

In a previous paper (Progr. Theoret. Phys., 36: 887(1966)) the authors investigated the effects of resonance scattering and nonmagnetic impurity scattering on the transition temperature of an anisotropic superconductor; the d-electron correlation effects are considered in this note to complete the investigation. A new self-energy diagram was computed for the d electron taking into account an extra term not previously included. Equations are presented that were used for developing the self-energy. (J.H.M.)

20907 SPECIFIC HEATS AT LOW TEMPERATURES. Gopal, E. S. R. The International Cryogenics Monograph Series. Third Volume. London, Heywood Books, 1966. 248p. 70s.

The field of low-temperature specific heats is surveyed at a level suitable for graduate courses. After outlining the thermodynamic background, specific heat behavior (lattice, electronic, and magnetic contributions) of solids, liquids, and gases is discussed in detail. Considerable practical information is included on calorimetric and refrigeration problems; for instance, the basic theory, tables, and supplementary information is given to enable the reader to calculate the refrigeration needed to cool any piece of apparatus to a desired point. Six-figure tables of Einstein and Debye internal energy and specific heat functions are given in an appendix. (M.H.R.)

20908 ENTROPY AND LOW TEMPERATURE PHYSICS. Dugdale, J. S. London, Hutchinson University Library, 1966. 206p.

Subjects discussed include a historical review of the study of temperature and heat, the first and second laws of thermodynamics, how entropy is measured and used, the statistical approach to entropy, application of entropy to solids and gases, the third law of thermodynamics, and the production and measurement of low temperatures. (A.G.W.)

Plasma and Thermonuclear Physics

Refer also to abstracts 20943 and 20988.

20909 (MATT-Q-23) ANNUAL REPORT, JANUARY 1–DECEMBER 31, 1965. (Princeton Univ., N. J. Plasma Physics Lab.). Apr. 1966. Contract AT(30-1)-1238. 336p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate abstracts were prepared for the four included sections. (M.O.W.)

For abstracts of individual sections see: 20915, 20916, 20943, and 20988.

20910 PROCEEDINGS OF THE SEVENTH INTERNATIONAL CONFERENCE ON PHENOMENA IN IONIZED GASES, BELGRADE, 22–27 AUGUST 1965. VOLUME I. ELECTRONIC AND IONIC COLLISION PHENOMENA, SURFACE PHENOMENA, ELECTRICAL DISCHARGES. Perovic, B.; Tosic, D. (eds.). Belgrade, Gradevinska Knjiga Publishing House, 1966. 863p. (CONF-650806-(Vol.1)).

Two hundred and thirteen papers are included on the following subjects: single-collision processes, collision processes in swarms, interaction with solids, emission from solids, low-pressure discharges, and high-pressure discharges. (M.O.W.)

20911 PROCEEDINGS OF THE SEVENTH INTERNATIONAL CONFERENCE ON PHENOMENA IN IONIZED GASES, BELGRADE, 22–27 AUGUST 1965. VOLUME II. PLASMA PHYSICS. Perovic, B.; Tosic, D. (eds.). Belgrade, Gradevinska Knjiga Publishing House, 1966. 849p. (CONF-650806-(Vol.2)).

One hundred and ninety eight papers are presented on the following subjects: fundamental plasma processes, transport processes, plasma in magnetic field, wave–plasma interactions, plasma radiation, stability problems, and shock waves. (M.O.W.)

20912 PROCEEDINGS OF THE SEVENTH INTERNATIONAL CONFERENCE ON PHENOMENA IN IONIZED GASES, BELGRADE, 22–27 AUGUST 1965. VOLUME III. DIAGNSOTIC METHODS AND APPLICATIONS. Perovic, B.; Tosic, D. (eds.). Belgrade, Gradevinska Knjiga Publishing House, 1966. 420p. (CONF-650806-(Vol.3)).

One hundred and four papers are presented on the following subjects: methods of plasma diagnostics, ion and plasma sources, and different applications. (M.O.W.)

Confinement and Heating of Plasma

20913 (IPP-2/56) LADUNGSTRAEGERVERLUSTMECHANISMEN IM SCHWACHIONISIERTEN TOROIDALEN MAGNETOPLASMA. (Particle Loss Mechanisms in a Weakly Ionized Toroidal Magnetoplasma). Karger, F. (Institut fuer Plasmaphysik, G,m,b,H., Garching (West Germany)). Feb. 1967. 49p. (In German). Dep. mn.

Thesis. Submitted to Technische Hochschule, Munich.

In a previous paper discrepancies between theory and experiment were found on investigating the positive column in a curved magnetic field. These are ascribed here to the fact that the plasma concentrates at the cathode end of the magnetic field coils, this having a considerable influence on the form of the transverse density profile and on the stability behavior. A special alternating field method was used to eliminate the influence of this concentra-

tion effect on the measurements of interest and to increase by more than an order of magnitude the critical magnetic field strength for the onset of the helical instability of the positive column. This made it possible to check in detail the theory of a stable, weakly ionized toroidal magnetoplasma (potential profile, density profile, charge carrier losses). The theoretically predicted transverse electric field strength leading to the torus drift was observed, while the outward density displacement due to the torus drift did not occur. It was proved that the reason for this was an effect which results from a transverse gradient in the rate of ionization (grad ξ effect) and which causes a substantial reduction of the charge carrier losses. In the decaying plasma with vanishing longitudinal electric field, on the other hand, the outward density displacement was recorded in accordance with the theory. The influence of the toroidal curvature on the magnetic field strength at which the helical instability sets in and on the turbulent state of the positive column was also investigated. It was also possible to verify the influence of the grad ξ effect on the helical oscillation. The grad ξ effect may be important for the early heating phase in projected toroidal fusion machines with neutral gas stabilization. (auth)

20914 (IPP-2/57) THE RESISTIVE PLASMA LOADING OF A STIX COIL. Cattanei, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Feb. 1967. 21p. Dep. mn.

The ratio Q of the inductive reactance of a periodic induction coil to the corresponding resistive plasma loading was evaluated by approximating the current in the coil by a stepped-sheet current distribution. The coil is assumed to be around a homogeneous cylindrical cold plasma with a constant magnetic field along the axis. The turns (or sets of turns) in the coil are spaced periodically along the axis and the current passing through two adjacent turns is equal but opposite in phase. For the case of coupling resonance, i.e., when the wavelength of the induction coil is equal to the wavelength of one of the modes of free oscillation for ion cyclotron waves in a cylindrical plasma, the ratio Q was plotted for turns connected both in series and in parallel as a function of the distance between two successive turns, the number of turns assumed to be unity. (auth)

20915 (MATT-Q-23, pp 1-90) RESEARCH WITH THE MODEL C STELLARATOR. (Princeton Univ., N. J. Plasma Physics Lab.).

Discussions and results of the following studies are reported: (1) power input and output during ICRH (ion cyclotron resonance heating), (2) confinement of plasma heated by ICR in C stellarator, (3) particle loss and influx rate for helium discharges in the C stellarator following ICRH, (4) fast neutral emission from ICH plasma in the C stellarator, (5) limitation on ICH in the local mirrors of the C stellarator, (6) collisionless heating of electrons by ion cyclotron waves, (7) heating of plasma by hydromagnetic wave, (8) density decay rates in C stellarator afterglows with Taylor-type minimum B fields, (9) effect of ion mass in afterglow plasmas, (10) effect of an imposed electric field on particle confinement in the C stellarator, (11) induced plasma rotation in the C stellarator, (12) the difference in character between fluctuations at high and low ohmic heating currents, (13) temperature, density, and potential distributions during ohmic heating in the C stellarator, (14) measurement of recombination rate coefficient of He^{++}, and (15) experimental study of magnetic surfaces. (M.O.W.)

20916 (MATT-Q-23, pp 321-8) SPECIAL PROGRAMS IN PHYSICS AND ENGINEERING. (Princeton Univ., N. J. Plasma Physics Lab.).

The specific studies described are directed ultimately toward understanding the behavior of possible blanket fluids for stellarators under typical neutron irradiation. The studies briefly mentioned are: chemical reactions produced by radiation, chemical kinetics of rapidly moving atoms, and the radiolysis of molten lithium nitrate. (M.O.W.)

20917 (ORO-3110-8) RF HEATING OF COLLISIONLESS PLASMAS. Progress Report No. 6. Schlueter, Hans (Texas Univ., Austin. Dept. of Physics). Feb. 28, 1967. Contract AT(40-1)-3110. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Several investigations are being made to analyze the rf heating of collisionless plasma. Among these are: the influence of density gradients on resonance loading, the resonant behavior of finite length plasma, the observation of ion modes excited at the hybrid ion-electron resonance, measurements at the improved Q device, and investigations in the transition region to the noncollisional domain. (M.O.W.)

20918 TRANSPIRATION COOLING OF A CONSTRICTED ELECTRIC-ARC HEATER. Anderson, J. E.; Eckert, E. R. G. (Univ. of Minnesota, Minneapolis). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 699-706(Apr. 1967).

The performance capability of a transpiration-cooled constricted arc heater has been analyzed. A first approximation using an integral form of the energy equation determines the constrictor length required to develop the temperature field. A similarity solution of the differential equations expressing conservation of mass, momentum, and energy is then obtained for the developed flow. Limitations on the arc performance are investigated, and the transpiration-cooled arc is compared with an arc having a water-cooled constrictor. Numerical calculations for hydrogen at atmospheric pressure indicate that higher peak temperatures can be expected with the transpiration-cooled arc, whereas the maximum mass-flow averaged enthalpy is approximately the same for both types. (auth)

20919 SOME NEW STABLE TOROIDAL PLASMA CONFIGURATIONS. Grad, Harold (New York Univ., New York). Contract AT(30-1)-1480. Phys. Rev. Lett., 18: 585-90(Apr. 10, 1967).

In an earlier paper it was shown that plasma containment in a toroidal geometry is likely to be poor unless the particle distribution function $f(\epsilon,\mu)$ is the same on all flux surfaces. In a mirror geometry, Taylor has shown that this special distribution function (under certain restrictions) yields satisfactory containment and stability when it is combined with a minimum B field. Exactly the same situation is shown to hold in a torus. Several simple explicit examples are given of vacuum magnetic wells in a toroidal geometry. It is also indicated how one might be able to construct similar stable, contained, high-β toroidal plasmas, e.g., as in a toroidal θ pinch. (M.O.W.)

20920 TURBULENT HEATING OF A PLASMA BY A CURRENT IN A MAGNETIC MIRROR FIELD. Babykin, M. V.; Gavrin, P. P.; Zavoiskii, E. K.; Nedoseev, S. L.; Rudakov, L. I.; Skoryupin, V. A. Zh. Eksp. Teor. Fiz., 52: 643-56(Mar. 1967). (In Russian).

The mechanism of turbulent heating of a plasma by a high-density current flowing parallel to the magnetic axis of a magnetic mirror machine is investigated. It is shown that the observed heating of the plasma exceeds the heating due to pair collisions by not less than several orders of magnitude. The dependence of the heating efficiency on time and voltage applied to the plasma is determined. It is demonstrated that the conclusions arrived at in the papers of Karchevskii et al. are erroneous. (auth)

20921 ELECTRON BEAM HEATING OF THE PLASMA IN A MAGNETIC MIRROR FIELD. Blinov, P. I.; Zakatov, L. P.; Plakhov, A. G.; Chikin, R. V.; Shapkin, V. V. Zh. Eksp. Teor. Fiz., 52: 670-6(Mar. 1967). (In Russian).

Heating of a plasma by an electron beam in an adiabatic trap with a mirror ratio R = 5.25 is studied in a broad range of experimental conditions. A hot plasma with T = 50 keV and $nT = 2 \times 10^{15}$ eV·cm^{-3} and separated from the walls has been obtained. The resonance nature of the dependence of nT on the magnetic field is found. With increase of the initial concentration of the plasma the maximum of the resonance curve shifts in the direction of large magnetic field strengths. The efficiency of plasma heating continuously rises with increase of the electron beam energy. The lifetime of the hot component of the plasma accords with the electron escape time from the trap due to collisions with the neutral component of the plasma. In some cases, in a quiescently decaying plasma, instabilities appear which are accompanied by a sharp drop of nT, and a flare of uhf and x radiation. (auth)

Diagnostics of Plasma

Refer also to abstracts 20015 and 20986.

20922 (CEA-R-3097) CINEMATOGRAPHIE DE PHENOMENES TRANSITOIRES FAIBLEMENT LUMINEUX A L'AIDE D'AMPLIFICATEURS DE LUMINANCE. (Cinematography of Weakly Luminous Transient Phenomena Using Image Converters). Stevenin, Pierre; Jacquot, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1966. 22p. (In French). Dep. mn.

After a review on the physics of optical informations emitted by a light source of weak intensity and short duration, a high gain device is described by associating two image converters. The present specifications are given in the domain of high speed cinematography and spectrometry. (auth)

20923 (IPP-2/54) DIE HOCHFREQUENZ-RESONANZ-SONDE. (The Radio-Frequency Resonance Probe). Peter, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec. 1966. 67p. (In German). Dep. mn.

Direct and alternating currents of an rf resonance probe were investigated experimentally in the frequency range from 1 to 100 Mc in a quiescent cesium plasma. The measurements in the plasma are explained by calculations and measurements with

a lumped-constant equivalent network ("plasma simulator"). It is shown that the ac current to the probe is strongly influenced by the capacitance of the cable leading to the probe. A device to compensate this cable capacitance is developed and used. Furthermore, it is shown for the first time that the double (or divided) main resonance maximum, occurring frequently with dc and ac currents to the resonance probe, is generally due to the influence of a second reference electrode. A simple and direct ("focus") method for very precise plasma density determination (from the intersection point of the rf current vs. frequency curves with probe voltage as parameter) is developed and compared with ac transmission current and Langmuir probe measurements at plasma densities between 2×10^6 and 3×10^7 cm^{-3}. Agreement was obtained between these three experimental methods within their margins of error. The comparison leads to a better understanding of the measured Langmuir characteristic and of the Cs plasma of the "Alma I" device. (auth)

20924 DOUBLE-PROBE METHOD FOR MEASURING ELECTRIC CONDUCTIVITY OF LOW-TEMPERATURE PLASMA. Khozhatelev, M. B.; Yarin, L. P. (Kazakh Scientific-Research Inst. of Power Engineering, Alma-Ata, USSR). Teplofiz. Vysok. Temp., 4: 611-14(Sept.-Oct. 1966). (In Russian).

A modified probe method for measuring electric conductivity of low-temperature plasma, taking into account the influence of pre-electrode layer on the probe response, is described. Probes with regulated interelectrode gaps were used, permitting experimental determination of the potential drop in the pre-electrode layers. This obviates consideration of the potential drop in calculations of the magnitude of the electric conductivity. (R.V.J.)

20925 MAGNETIC METHOD FOR MEASURING ELECTRIC CONDUCTIVITY OF IONIZING GASES. Fedulov, V. I.; Efremova, G. D. Teplofiz. Vysok. Temp., 4: 615-20(Sept.-Oct. 1966). (In Russian).

A magnetic method of measuring electric conductivity of moving plasma was studied. A "dropping cylinder" method was developed in order to improve calibration conditions and, thus, improve precision of the measurements. The magnitude of the signal as a function of the modeling cylinder was determined, and the resolving power along the length was evaluated. Optimum methods were developed for treatment of the signals. Measurements of electric conductivity carried out in a shock tube were in agreement with published data. (tr-auth)

20926 COMPUTATION OF STATISTICAL ATOMIC SUM. Veksler, L. S.; Dubner, V. M. Teplofiz. Vysok. Temp., 4: 730-2(Sept.-Oct. 1966). (In Russian).

Statistical calculations for the bound electron state in monovalent atoms were used in calculations of low-temperature plasma properties. (R.V.J.)

20927 UHF DIAGNOSTICS OF PLASMA JETS. Il'in, S. D.; Likhachev, V. M.; Petrusev, S. S.; Chernetskii, A. V. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 289-92(1967). (In Russian).

Combined two-range radiolocation methods and translumination methods, which are the expansion methods of superhigh frequency diagnostics, were used in an investigation of the properties and motion of the front of a plasma jet from a coaxial injector. (R.V.J.)

20928 RADIATIVE TRANSFER IN SPECTRAL LINES. Biberman, L. M. (Moscow Power Engineering Inst.). Pure Appl. Chem., 13: 393-402(1966).

The properties, kinetics, and diagnostics of a plasma are to a considerable degree determined by the concentration of excited atoms, and their distribution in space and time. The concentration of excited atoms in optically dense layers is conditioned, together with collisional processes, by radiative transfer and, especially by radiation transfer in spectral lines by multiple successive acts of emission and absorption. The main results are presented of the modern radiative transfer theory, its experimental evidence and some applications. (M.O.W.)

20929 MICROWAVE PLASMA NOISE IN A DC ELECTRIC FIELD. Rozhkov, V. V. (Kharkov State Inst. of Measurement and Measuring Instruments). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 43-9(1966). (In Russian).

Determination of the electron temperature from the microwave noise may be used for plasma diagnostics. The gas temperature may be determined indirectly from the known electron temperature on the basis of the correlation between that temperature and the weakly ionized, homogenous gas within a dc field, as in the case of gas discharge tubes and dc electric arcs. Knowledge of the electron velocity distribution functions allows one to calculate nearly all other plasma characteristics. The calculations made indicated that there is a frequency region, within which the noise temperature coincides with the electron temperature. A graphic method was derived for determining the optimum region for each specific case. The formulas obtained may be used for determining plasma parameters, such as collision frequencies, mean free paths of electrons, if the gas temperature is simultaneously determined by optical methods, such as the Doppler broadening of spectral lines. (TTT)

20930 APPLICATION OF THE MP-59M INSTRUMENT FOR PLASMA DIAGNOSTICS. Kandyba, V. V. (Kharkov State Inst. for Measurements and Measuring Instruments). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 108-9 (1966). (In Russian).

The modulation pyrometer MP-59M was designed specifically for the measurement of the plasma temperature on the basis of the intensity of spectral lines. It was also used as a high-resolution spectrograph; if there is "saturated" emission at the center of the line, the ordinate is a function of the temperature of the excited lines responsible for the emission of the line in question. The Fabry–Perot interferometer makes it possible to operate the instrument in a broad spectral range with high resolution. The instrument was subsequently adapted to the measurement of the velocity of the motion of the plasma components, the constancy of the chemical composition, establishment of an equilibrium state, etc. It may also be used for stabilizing and controlling plasmatron operations. (TTT)

20931 INVESTIGATION OF ARC JET TEMPERATURE-MEASUREMENT TECHNIQUES. Incropera, Frank P.; Leppert, George (Stanford Univ., Calif.). ISA (Instrum. Soc. Amer.) Trans., 6: 35-41(Jan. 1967).

From a review of the arc jet literature, three techniques are found to be best suited to the task of plasma jet temperature measurement. Two of these techniques are spectroscopic and are referred to as the Larenz and two-line methods, and the third is calorimetric and operates by insertion of a probe in the plasma stream. An uncertainty analysis performed on each of the selected methods indicates that the most suitable spectroscopic technique is a combination of an ion–neutral, two-line method with the Larenz method. Spectroscopic and calorimetric probe measurements of temperature profiles in the same argon plasma source agree to within 4%, which is also the expected uncertainty predicted from the analysis. Criteria are proposed which may be used to select the diagnostic technique best suited to one's application. (auth)

20932 PARAMETRIC DESCRIPTION OF AN INHOMOGENEOUS, OPTICALLY DENSE PLASMA. II. THE DOPPLER CONTOUR OF A SPECTRAL LINE. Preobrazhenskii, N. G.; Kolobova, G. A. (Novosibirsk State Univ., USSR. Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 92-5(1966). (In Russian).

The source-inhomogeneity parameter over the cross section of a spectral-line contour in the case of a "pure" Doppler distribution is calculated. The dependence of the inhomogeneity parameter on the frequency is found to be greater than in the case of a dispersion distribution. It is shown that this circumstance must be taken into account when diagnosing a plasma from a spectral-line contour. (Int. Aerospace Abstr.)

20933 PARAMETRIC DESCRIPTION OF AN INHOMOGENEOUS, OPTICALLY DENSE PLASMA. I. THE DISPERSION CONTOUR OF A SPECTRAL LINE. Preobrazhenskii, N. G.; Kolobova, G. A. (Novosibirsk State Univ., USSR. Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 88-92(1966). (In Russian).

The source-inhomogeneity parameter for various excited-atom distributions and line-width variations over the discharge cross section for a "pure" dispersion contour of a spectral line was calculated. The dependence of the inhomogeneity parameter on the frequency is established and found to vary with an increase in the radial dependence of the line width. The need to take this factor into account when calculating the contour of a self-inverted line is indicated. (Int. Aerospace Abstr.)

20934 CALCULATION OF PLASMA COMPOSITION AND ITS APPLICATION TO TEMPERATURE DETERMINATION. Boegershausen, W.; Krempl, H. (Technische Hochschule, Munich). Z. Angew. Phys., 22: 165-70(1967). (In German).

The composition of an argon, helium, and nitrogen plasma in the region from 4000 to 50,000°K is calculated. The influence of the lowering of the ionization potential after the theory of Unsöld on the sum of states, the composition of the plasma, and the emission coefficient of some lines is discussed. The results are used to determine the radial distribution of temperature in a free-burning 150-A argon and helium arc. The dependence of temperature distribution from the distance from the cathode is described. Free-burning noble-gas arcs also show a plateau in radial temperature distribution like arcs in molecular atmosphere. This plateau is due

to the energy set free by recombination of single ionized atoms. The temperature curves of a plasma jet give a characterization lying between wall-stabilized and free-burning arcs. (auth)

20935 ASYMMETRIC BROADENING OF THE BALMER LINE H_β IN PLASMA. Wende, B. (Physikalisch-Technische Bundesanstalt, Brunswick and Berlin). Z. Angew. Phys., 22: 181-5(1967). (In German).

An asymmetric broadening of the Balmer line H_β is observed in a hydrogen-doped argon arc plasma. The results can be represented qualitatively by the theory of Kudrin–Sholin. The symmetric profile predicted by the broadening theory of Griem–Kolb–Shen is in better agreement with the experiments for the blue wing of the line than for the red one. (auth)

20936 THOMSON SCATTERING OF RUBY LASER LIGHT BY SHOCK WAVE PLASMA. Izawa, Yasukazu; Kabuto, Hideaki; Yokoyama, Masahiro; Yamanaka, Chiyoe. Technol. Rep. Osaka Univ., 16: 515-21(Oct. 1966).

Thomson scattering of a Q-switched ruby laser beam is a very important diagnostic technique for high-density and high-temperature plasma. Thomson scattering was measured from the shock-produced plasma. Spurious scattering of a laser light has been reduced in a tolerable level by using a special chamber. In order to determine the electron density from Thomson scattering of a Q-switched laser, Rayleigh scattering from one-atm-pressure air was used as a measuring standard. In these experiments, electron densities behind the reflected shock wave at initial pressure of Ar of 1-mm Hg and for Mach number of 10 to 13 were determined as about 10^{16} cm^{-3}, which were in good agreement with calculated values by shock theory or the density measured by an optical interferometry measurement. The spectral distribution of the scattered light was also determined, and agrees very well with the theoretical value for a parameter $\alpha = 0.85$. In this case, the electron temperature behind the reflected shock wave at initial pressure of Ar of 0.4-mm Hg and Mach 17 was 23,000°K, in good agreement with that obtained from the spectral line intensity measurement. (auth)

20937 FOCUSING LENS FOR ELECTROMAGNETIC WAVES. Itakura, Kiyoyasu; Azakami, Takashi; Hamai, Masanao. Technol. Rep. Osaka Univ., 16: 459-69(Oct. 1966).

The treatment of lenses which converge the electromagnetic waves into a line or point focus and the field distribution near a focus which is calculated approximately by the diffraction theory is described. The calculations may be applied to the study of plasma constants by means of microwaves or millimeter waves and to other fields. (tr-auth)

20938 TIME RESOLVED RADIATION INTENSITY DISTRIBUTION IN A FXR DISCHARGE. Sundstroem, I.; Haendel, S. K.; Persson, J. E. (Uppsala Univ.). Z. Phys., 200: 499-510(1967).

Time-resolved intensity distribution of x radiation and visible light from a flash x-ray (FXR) discharge was investigated. The results obtained indicate that the discharge is "glow-like" with a dark space in front of the anode during the formative period. The high current arc is established at the constriction of the discharge column by its own magnetic field. (auth)

20939 DIELECTRIC WAVE GUIDE AS PLASMA PROBE. Kreuzer, H. J.; Mueller, K. G. (Univ., Bonn). Z. Phys., 200: 541-55(1967). (In German).

A microwave interferometer is described, by which the electron density in a small volume inside of a plasma can be measured. By dielectric rods acting as waveguides the microwave is led to this volume. For a given electron density the phase shift is calculated for this volume and for the dielectric rods. By a suitable choice of the radius and the dielectric constant of the rods the phase shift along the rods can be suppressed. The influence of plasma sheaths is discussed. In a special application to the plasma of the negative glow these interferometric measurements are compared with Langmuir probe measurements. (auth)

20940 MICROWAVE MEASUREMENTS OF ELECTRON DENSITY AND COLLISION FREQUENCY IN ELECTROMAGNETICALLY PRODUCED SHOCK WAVES. Makios, W. (Institut fuer Plasmaphysik, GmbH, Garching, Ger.). Z. Naturforsch., 21a: 2040-6(Dec. 1966). (In German).

Microwave measurements were made of the electron density and the electron collision frequency in the plasma between the shock front and the discharge plasma of electromagnetically produced shock waves. These investigations were carried out in argon and hydrogen at $p_0 = 2$ mm Hg initial pressure and velocities ranging from $M = 5$ to $M = 20$. At higher velocities the discharge plasma advances right into the shock front. A 4-mm-microwave transmission interferometer was used. A system of Lecher wires in the measuring arm of the interferometer provided a spatial resolution of approximately 1 to 2 mm and proved successful in measuring the electron density distribution between the shock front and the following discharge plasma. In the case of hydrogen the rise of the electron density in the shock front is caused by compression of the precursor electrons. In argon, on the other hand, most of the electrons are produced behind the shock front. A typical relaxation of the electron density towards equilibrium was measured. It was also possible to measure the electron collision frequency in argon as a function of time (and hence of the distance from the shock front). (auth)

Kinetics of Plasma

Refer also to abstract 20988.

20941 (AD-641145) ABSORPTION AND EMISSION COEFFICIENT DETERMINATION BY A ZONAL RING TECHNIQUE IN A CIRCULAR CYLINDRICAL PLASMA COLUMN. Oss, John P. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). June 1966. 67p. (ARL-66-0110). CFSTI $3.00 cy, $0.65 mn.

An automated data acquisition and reduction system is described for obtaining absorption and emission coefficients in a circular cylindrical plasma column. The data reduction is based on a zonal ring method with the absorption coefficient accounted for in the emission coefficient calculations. Computer programs are included. (auth)

20942 (IPP-3/52) UEBER DAS UNTERSCHIEDLICHE IONISATIONSGLEICHGEWICHT WASSERSTOFF- UND ALKALIAEHNLICHER IONEN IN OPTISCH DUENNEN PLASMEN. (The Difference Between the Ionization Equilibria of Hydrogen-Like and Alkali-Like Ions in Optically Thin Plasmas). Mahn, C. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Feb. 1967. 77p. (In German). Dep. mn.

Thesis.

There are many plasmas in which the populations of the various energy states of ions and electrons assume a steady state, but complete local thermal equilibrium is prevented because, on the one hand, radiation absorption is absent and, on the other, the electron density is too low. The following calculations for a plasma without radiation absorption show that: Where hydrogen-like ions are involved it is in order to dispense with detailed calculations and describe the ionization equilibrium with the corona formula, which is obtained essentially by equating the collision ionization processes from the ground state with the radiative recombination processes to the ground state. In the case of other ions, however, neglecting the excited states may result in serious errors. This is because the corresponding terms — unlike those for hydrogen-like ions, which are relatively near the ionization limit — are distributed much more uniformly between the ground state and ionization limit. The implications of this behavior are discussed with reference to alkali-like ions. A model for the term systems and the collision and radiation coefficients is used to derive quantitative results. These may be expressed by approximation formulas which probably describe the ionization equilibrium better than the corona formula. According to these the ratio of the densities of the lithium-like O VI ions and the next higher level of ions (O VII), for instance, may differ (for electron densities $n_e = 5 \times 10^{17}$ cm^{-3}) from the result of the corona formula by a factor of 20. (auth)

20943 (MATT-Q-23, pp 91-179) RESEARCH WITH SMALL DEVICES. (Princeton Univ., N. J. Plasma Physics Lab.).

Discussions and results are presented for each of the following: fluctuations in microwave-generated discharges, observations of whistler waves propagating in InSb crystals at an angle with respect to a magnetic field. Instability in a hot electron plasma, harmonic generation in plasmas, experiments with Cs plasmas in a magnetic field with variable curvature, enhanced plasma losses in a Q device, Kelvin–Helmholtz instability in a cesium plasma, plasma oscillations at harmonics of the ion gyrofrequency, electron cyclotron heating of alkali plasmas, production of a thermally ionized plasma with negative ions, experimental results on the ion-beam excitation of drift waves in an alkali plasma, turbulence of a low-β plasma, confinement of a Cs plasma in a mirror field, and plasma column end effects. (M.O.W.)

20944 (NP-16644) KINETIC THEORY OF PLASMAS. Lie, T. J. (Illinois Univ., Urbana, Coordinated Science Lab.). Feb. 1967. Contract DA28-043-AMC-00073(E). 85p. (R-341).

Based on the picture of field-particle scattering, an attempt is made to derive kinetic equations for plasmas. The system is assumed to have overall neutrality and to be under no external forces. A linear approximation which corresponds to linearizing the Vlasov equation is used to truncate the hierarchy of equations. The whole problem is reduced to exactly solving a familiar singular integral equation. A coupled set of temporal equations for the field energy and the homogeneous Fourier component of the

one-particle distribution function is obtained under arbitrary initial correlations. The particle part of the equations consists of two terms: the one is the well-known Balescu–Lenard collision integral and the other is what one obtains in the quasi-linear theory of plasmas based on the Vlasov equation. The resonant scattering part of the equations agrees with the Pines–Schrieffer equations. Both the stable and unstable cases are considered, and the motions of ions are also included. The theory is valid regardless of whether the system is homogeneous or non-homogeneous. (auth)

20945 (ORNL-TM-1797) NUMERICAL METHOD FOR TRANSFORMING SURFACE AND SPACE PROBE DATA. Durfee, R. C. (Oak Ridge National Lab., Tenn.). Mar. 10, 1967. Contract W-7405-eng-26. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A project was undertaken to find an effective method of relating observed visible light intensity distributions to the actual visible light emission within a confined plasma. The physical system consisted of a cylindrically confined plasma which was bombarded with an electron beam. Visible light was collected by a scanning system from a conical volume of the plasma. Two programs have been written which calculate the desired light emission from these radiation measurements taken external to the plasma. The first program works with a two dimensional system in which the plasma is contained within a circular surface, and radiation measurements are made with a wedge-shaped surface probe. The second program works with the true three dimensional system in which the plasma is contained within a cylinder, and radiation measurements are made with a conical volume probe. This work extends that of Nestor and Olson who considered only the planar case with scanning systems of lines and segmental areas. (auth)

20946 PLASMA CHARGED-PARTICLE SOURCE. Munakata, Tadasuke (to Hitachi Ltd.). Japanese Patent 1966-7759. Apr. 19, 1966. Filed Oct. 23, 1964.

In the plasma charged-particle source proposed, an improvement is made in the arc to raise the charged-particle production. It consists of the following: the evacuated discharge vessel; the hot cathode and the anode having a hole for drawing out the charged particles, which are opposed to each other with the discharge vessel between them; a device for introducing a low-pressure gas into the discharge vessel; a device for inducing an arc discharge between the two electrodes and thus producing the necessary plasma; a device for producing a magnetic field in parallel with the arc discharge and thus focusing the (discharge) plasma; and a device for producing the electric field, which is used for drawing out positive or negative charged particles from the plasma. Outside adjustments can be made of relative positions of the anode hole and the cathode in the direction perpendicular to the axis of the arc discharge. (NSA of Japan)

20947 KINETIC THEORY OF ELECTROMAGNETIC WAVE PROPAGATION THROUGH A MAGNETOACTIVE PLASMA LAYER. Kondratenko, A. N.; Onishenko, I. N. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 175-85(1967). (In Russian).

The electromagnetic wave propagation through the layer of a plasma being in a constant magnetic field parallel to plasma boundaries is considered. The electric vector of an incident wave is also assumed to be parallel to the magnetic field. The coefficients of reflection, propagation, and absorption of the wave energy were found. The form of the field in plasma was determined for various particular cases. (auth)

20948 PLASMA INVESTIGATION IN A REVERSED-CURRENT ELECTRON BOMBARDMENT ION ENGINE. Masek, Tommy D. (California Inst. of Tech., Pasadena). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 692-8(Apr. 1967).

Results are presented for an experimental study of the plasma in a cesium electron bombardment ion engine. The engine configuration used has a center anode and an annular cathode, the inverse of conventional bombardment engines. The engine is approximately 10 cm in diameter and uses a molybdenum-surfaced cathode through which the propellant is fed. Measurements of electron temperature, ion density, and plasma potential made with a single movable Langmuir probe are presented for several operating conditions. The effects of propellant utilization, magnetic field, and arc conditions on the plasma properties are graphically presented. The plasma measurements are compared with those made in conventional electron bombardment engines and indicate that the reversed cathode–anode configuration improves the radial ion distribution uniformity in the plasma by about a factor of five over the conventional engines. (auth)

20949 STATISTICAL THERMODYNAMICS OF BOUND STATES IN PLASMAS. Ebeling, W. (Univ., Rostock, Ger.). Ann. Phys. (7), 19: 104-12(1967). (In German).

Using the method of Morita and the ionic solution theory of Friedman, the free energy of a system of nuclei and electrons is represented by a convergent cluster expansion. The n-th term of this expansion is given by the screened Slater sum of the n body problem. The Slater sum of two particles is calculated quantum mechanically for bound states ($E \lesssim -kT$) and classically for free states ($E \gtrsim -kT$). The second virial coefficient and the Saha equation for a hydrogen plasma are derived. Long-range, short-range and high-orbit divergencies are avoided. (auth)

20950 EXCITATION OF IONIC WAVE BY BEAM-PLASMA INTERACTION. Stainov, G.; Martinov, N. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 1119-21(1966).

A theoretical investigation was made of the spectrum of ionic waves in a homogeneous plasma, located in a constant outer homogeneous electric field and interacting with a beam of charged particles. The dispersion equation was analyzed for various conditions. (M.O.W.)

20951 QUASISTATIONARY THEORY OF NONSTATIONARY PROCESSES. Ul'yanov, K. N. (Lenin All-Union Electrotechnical Inst., USSR). Teplofiz. Vysok. Temp., 4: 601-5(Sept.-Oct. 1966). (In Russian).

A continuation is presented of earlier work where a general theory of nonstationary processes in a dense nonequilibrium plasma was developed. The special case is considered when the particle concentration in a local-collisional plasma consisting of heavy atoms with relatively uniform level distribution can follow the vibrations of the temperature, so that the relaxation process is quasi stationary (with respect to the concentrations). The relaxation times are then determined by the intensities of the sources and by the energy loss. In this case the system of equations for the plasma, derived in the earlier paper, can be solved by quadratures. Criteria are established under which the relaxation can be regarded as quasi stationary, and reduce to the requirement that the energy acquired or lost by the electrons per unit time be much smaller than the energy that the free electrons exchange reversibly with the atoms in the ground state. The quasi-stationary analysis makes it possible to calculate the time variation of the electron density and temperature and the concentration of the atoms. By way of an example, the relaxation lengths of the electrons (and consequently their concentration and the conductivity) are calculated at the input into the channel of a nonequilibrium magnetohydrodynamic generator operating with a mixture of cesium vapor and helium. It is shown that the resultant relaxation length (~4 cm) does not strongly affect the operation of a real MHD generator, but can be important in the laboratory installations. (ATD)

20952 INVESTIGATION OF THE RADIATING ABILITY OF ARGON AT HIGH TEMPERATURES AND PRESSURES. Golubev, V. A.; Ivanov, Yu. N. Teplofiz. Vysok. Temp., 4: 606-10(Sept.-Oct. 1966). (In Russian).

Equipment, procedures, and results of an experimental investigation of the radiating ability of argon heated in a dc arc at 11,000 to 12,000°K at pressures $\approx 5 \times 10^5 - 10^7$ N/m^2 are described. The absolute intensity of the argon-arc radiation was measured by comparison with a standard source (tungsten lamp), the spectrum of which was photographed on the same plate as that of the argon. The results show that with increasing pressure and current the total radiation energy of the argon increases in spite of a slight decrease in the diameter of the arc at approximately constant temperature on the discharge axis. This indicates that the degree of blackness of the argon increases with pressure. Comparison of the experimental data with the theoretical calculations shows satisfactory agreement. (ATD)

20953 KINETIC THEORY OF ELECTROMAGNETIC WAVES REFLECTION BY PLASMA. Popov, V. A. Radiotekh. Elektron., 11: 1878-9(Oct. 1966). (In Russian).

Previously it was shown that the magnitude of the surface charge formed on the boundary of a plasma excited by an external field is a function of the electron distribution in the plasma surface. An attempt was made to calculate the plasma impedance and surface charge on the plasma boundary for the case of diffused electron reflection and polarization of the incident wave. The results were compared with the data for mirror electron reflection and showed, that for the cold plasma, the magnitudes of the surface charge for the mirror and diffuse electron reflection from the plasma confining wall are identical. (R.V.J.)

20954 CHARGED PARTICLE FLOW TO THE CATHODE IN A PENNING TYPE DISCHARGE. Smirnitskaya, G. V.; Babertsyan, R. P. (Moscow State Univ.). Radiotekh. Elektron., 11: 1897-9(Oct. 1966). (In Russian).

Energy distribution of ions emitted into the post-cathode space at various angles in a tube with various geometries of the discharge spacing, and with various discharge parameters, was

investigated. It was shown that electron output depends on the geometry of the discharge spacing and discharge parameters. (R.V.J.)

20955 NUMERICAL SOLUTION OF DISPERSION RELATION FOR ELECTRON BEAM IN PLASMA. Enal'skii, V. A. Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 3-12(1966). (In Russian).

A numerical solution for the dispersion relation of an electron beam in a plasma was found for the case in which the thermal motion of the particles is described by the Maxwell distribution function. (R.V.J.)

20956 FLOW AND DIAGNOSTICS OF THE ELECTRIC CURRENT IN MOVING AND DISINTEGRATING PLASMA. Musin, A. K. (Lenin All-Union Electrotechnical Inst., Moscow). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 37-42(1966). (In Russian).

There are no methods available at present for the local measurement of the concentration of charged particles and of the kinetic coefficients in fast-flowing plasmas and in unsteady electric fields; therefore, the process involved in the formation of electric fields and currents and the creation and disintegration of a space charges within layers near the electrodes during the passage of disintegrating plasma were investigated; the corresponding case of applying an electric field on stationary, disintegrating plasma was also considered. Analytical expressions were derived for the nonlinear volt–ampere characteristics of the current in the plasma stream which is disintegrating because the charged particles are drained off by the field or by recombination. From these characteristics, the effective kinetic plasma coefficients, the distribution of electric fields and of charged particles may be determined. It was found that the volume recombination represents only a small correction in the disappearance of the charged particles at the electrodes. (TTT)

20957 INFLUENCE OF SOLID-PARTICLE ADMIXTURES ON THE ELECTRIC CONDUCTIVITY OF HIGH-TEMPERATURE NITROGEN JETS. Zake, M. V.; Straupmane, V. E. (Inst. of Energetics, Riga). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 66-72(1966). (In Russian).

While studying the electric conductivity of gases in a magnetogasodynamic apparatus, it was attempted to increase the electron concentration by introducing dispersed particles into the gas stream. Particles of carbon, calcium oxide, copper, magnesium and magnesium oxide were added to the high-temperature nitrogen jet, heated by arc. It was found that addition of dispersed magnesium oxide, calcium oxide or graphite particles did not result in the increase of the conductivity of the gas at temperatures up to 2800°K. Beyond that temperature, the metallic addition did not affect the conductivity; the other additives in the presence did cause an increase which, however was lower than that achieved with an addition potassium to the nitrogen. Below 2000°K, or if the copper and magnesium particles were not heated sufficiently rapidly, introduction of the dispersed phase resulted in the absorption of free electrons and reduction of the conductivity of the gas. Better results were obtained by means of thermoelectric emission from the surface of a heated anode. It is suggested to extend the investigation to the effect of dispersed particles with a dimension below 100 Å. (TTT)

20958 PROBLEMS CONNECTED WITH THE INVESTIGATION OF ELEMENTARY PROCESSES IN LOW-TEMPERATURE PLASMA. Kondratiev, V. N.; Nikitin, E. E.; Talrose, V. L. (Inst. of Chemical Physics, Moscow). Pure Appl. Chem., 13: 367-88(1966).

General problems of the theory of elementary processes in plasma are discussed. The problems connected with determining rate constants for the following reactions are discussed: (1) thermal dissociation of diatomic molecules, (2) thermal dissociation of polyatomic molecules, (3) exchange reactions, (4) excitation and ionization of atoms by electrons, (5) impact ionization, (6) recombination ionization, (7) electronic excitation, electron energy transfer, and charge exchange by collisions between atoms and molecules, (8) ion–molecular reactions, (9) dissociative recombination, and (10) associative ionization. (M.O.W.)

20959 ELECTROMAGNETIC INDUCTION IN PLASMA. Karlovitz, Bela (Combustion and Explosives Research Inc., Pittsburgh). Pure Appl. Chem., 13: 389-92(1966).

Brief discussions are presented on the diamagnetic moment of plasma, energy exchange between plasma and field, the extended field equations, voltage induced by plasma, and the inductive energy transfer between plasma and field. (M.O.W.)

20960 PROPAGATION OF ELECTROMAGNETIC WAVES IN A GUIDE COMPLETELY OR PARTIALLY FILLED WITH A PLASMA TRAVERSED BY AN ELECTRON BEAM IN THE PRESENCE OF A MAGNETIC FIELD. Bliman, Samuel; Bouchoule, Andre (CNRS, Paris. Univ., Paris, Orsay, France). Compt. Rend., Ser. B, 264: 22-4(Jan. 4, 1967). (In French).

The plasma and beam define separately self modes of propagation in the same geometry. The entire beam-plasma system gives rise to couplings. The dispersion diagram makes it possible to define their nature. The dispersion equation of the complete system was established without quasi-static hypotheses for a cold milieu of uniform density. (tr-auth)

20961 NONCOLLISIONAL DAMPINGS IN A HOT PLASMA. Rolland, Paul (CEN, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 264: 25-7(Jan. 4, 1967). (In French).

A method for the calculation of the non-collisional damping due to the reflection of electrons on the tubes and walls as well as to the mixture of phases associated with thermal agitation was given. This study completes and generalizes calculations presented previously. (tr-auth)

20962 DYNAMIC PRESSURES IN PLASMA JETS OF HELIUM AND ARGON IN AIR. Valentin, Pierre; Pinegre, Michel; Larcher, Ghislain (Faculte des Sciences, Rouen). Compt. Rend., Ser. B, 264: 31-4(Jan. 4, 1967).

The present experiments show a very sharp decrease of the flux of longitudinal movement quantities in the flame tip of a plasma jet. These experiments lead moreover to some orders of magnitudes with respect to the composition of these jets. (tr-auth)

20963 CORRECTIONS TO THE ASYMPTOTIC HOLTSMARK FORMULA FOR HYDROGEN LINES BROADENED BY ELECTRONS AND IONS IN A PLASMA. Griem, Hans R. (Univ. of Maryland, College Park). Astrophys. J., 147: 1092-9(Mar. 1967).

Expressions are given for the electron contribution to Stark broadening at large distances from the line center, referred to the quasi-static broadening by ions. Depending on distance from the line center and velocity, the electron contribution is calculated with the impact approximation using Lewis or Debye cutoffs, or with the quasi-static approximation. In addition to monopole–dipole interactions causing perturbations within the group of levels having the principal quantum number of the upper state of the line, some allowance is made for monopole–quadrupole interactions, for collision-induced transitions involving changes of principal quantum numbers, and for perturbations of the lower state of the line. By use of improved estimates for the relevant atomic matrix elements and the strong collision term, the correction factor to the asymptotic Holtsmark result for ion broadening is calculated to an estimated accuracy of 10% for almost all lines of the early hydrogen-line series, and estimates are given for higher-order terms in the asymptotic expansion and Debye shielding effects. The electron broadening, while at most about equal to quasi-static ion broadening, turns out to be significant under all practical conditions, even when these lie well within the validity regime of the impact approximation. (auth)

20964 APPROXIMATE DEPENDENCE OF THE HEAT FLOW TOWARD THE WALL IN THE CASE OF ELECTRIC ARC HEATING IN A CIRCULAR TUBE. Suksov, I. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 105-7(July-Aug. 1966). (In Russian).

In view of the widespread use of the electric-arc (plasmatron) heating method, the interaction between the heated gas and the wall of the heating system was theoretically studied, in order to develop a method for calculating the high-temperature transfer coefficients in the arc. It was found that under stabilized heating conditions and in the absence of flow in the tube, there is approximate correlation between the flow toward the wall, the electric field potential, the radius of the tube, the axial electrical conductivity, the axial thermal conductivity and the thermal conductivity within the wall. For the calculation, it was assumed that the outside of the cylindrical tube in which the gas was heated by the discharge was cooled in such a way as to allow its inner surface to reach a certain temperature. The results indicated that the approximation formula developed may be used to estimate the heat flow toward the wall; they agreed with data obtained in recent experiments and with results of more exact calculations. (TTT)

20965 FREE-BOUND MODEL OF THE PLASMA IN EQUILIBRIUM. Ecker, G.; Kroell, W. (Univ., Bochum, Ger.). Z. Naturforsch., 21a: 2012-22(Dec. 1966).

The plasma in thermodynamic equilibrium has been extensively discussed under the assumption that all particles can be classified as "bound" or "classically free." Under this assumption simple models led to divergences of the partition functions of bound and free particles as well as to discrepancies of the predicted level shift. On the basis of a quantum-mechanical treatment an "adapted free–bound approximation" is developed for the eigenstates and a classical approximation for the parti-

tion function of the free particles. It is a decisive feature of the analysis that it takes free-bound interaction into account. The results produce values for the free-bound limit and the limit of the series continuum. They also remove the divergence difficulties. (auth)

20966 DEGREE OF IONIZATION OF A PLASMA IN EQUILIBRIUM. Ecker, G.; Kroell, W. (Univ., Bochum, Ger.). Z. Naturforsch., 21a: 2023-7(Dec. 1966).

Previous investigations derived the Saha equation for a plasma in equilibrium applying the free–bound concept valid for an isolated electron–ion pair. In this investigation of the "adapted free–bound model" it was shown that due to the free–bound interaction the demarcation between free and bound states is shifted by $\Delta\chi = -e^2/r_0$. The influence of this shift of the ionization limit on the effective ionization energy in Saha's equation was studied. The lowering of the free–bound limit causes an increase of the effective lowering of the ionization energy in Saha's equation beyond the well-known e^2/D term resulting from the free–free interaction. This additional term itself is of the order $O(e^2/D)$ and therewith much stronger than the correction found from higher-order correlations of the free particles. On the other hand it is much smaller than the lowering of the free–bound limit. (auth)

20967 UNIFORM DESCRIPTION OF CORE AND SHEATH OF A PLASMA COLUMN. Ecker, G. (Univ., Bochum, Ger.); Kanne, H. Z. Naturforsch., 21a: 2027-32(Dec. 1966).

Weakly ionized plasmas bounded by insulated walls were studied earlier for the limiting cases of very-low and very-high pressure. These investigations base the particle kinetics either on the model of "collision dominated motion" or on the model of "inertia dominated motion." Corresponding model regions are matched neglecting the transition region. A weakly ionized plasma bounded by insulated walls is considered. Its particle production is due to electron collisions and its particle destruction due to wall recombination. Describing the electrons as in quasiequilibrium and ion–neutral interaction by constant mean-free-time collisions it is possible to derive for arbitrary plasma pressure an integrodifferential equation valid throughout the plasma core, the transition region and the sheath. No matching of model regions is required. The well-known Langmuir and Schottky theories are shown to be asymptotic solutions of this general treatment. (auth)

20968 INVESTIGATION OF THE ELECTRON-BEAM PLASMA. Herrmann, Winfried (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Naturforsch., 21a: 2033-9(Dec. 1966). (In German).

The beam plasma exists in at least two states: the "quiescent" state with low pressures and the "turbulent" state with high pressures of the neutral gas (argon in most experiments). The quiescent state is described theoretically. It is shown that the system should transport growing waves with frequencies just below the upper hybrid frequency $\omega_H^2 = \omega_p^2 + \omega_c^2$. These oscillations are found experimentally for $\omega_p > k_1\omega_c$, where k_1 has a value of about 0.35 in the experiments described. Increasing the pressure and the plasma density as well raises the amplitude of the oscillations. Then at the critical pressure the turbulent state with high density is produced very abruptly. The essential feature of this second state is the high energy loss of the beam particles. The dependence of the losses on the parameters of the system is studied in detail. The maximum losses may attain 50% of the original beam energy. Some other properties of the system are described. (auth)

20969 PRESSURE RISE IN A PLASMA DUE TO THE NERNST EFFECT. Grassmann, P. H.; Klueber, O.; Wulff, H. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett., 24A: 324-5 (Mar. 13, 1967).

In a completely doubly ionized He plasma a large pressure rise toward the axis was found. This is due to a thermomagnetic effect (Nernst effect) apparently unobserved hitherto in experimental plasma physics. (auth)

20970 COLLISIONAL EFFECTS IN PLASMAS: DRIFT-WAVE EXPERIMENTS AND INTERPRETATION. Hendel, H. W.; Coppi, B.; Perkins, F.; Politzer, P. A. (Princeton Univ., N. J.). Phys. Rev. Lett., 18: 439-42(Mar. 20, 1967).

Experimental results are reported on low-temperature alkali plasmas in strong magnetic fields and their interpretation was made in terms of collisional drift modes, in which diffusion over the transverse wavelength, resulting from ion–ion collisions, plays an important role. Frequencies, amplitudes, and azimuthal mode numbers of steady-state drift waves were determined as functions of magnetic field strength and ion density. (M.O.W.)

20971 RUNAWAY CURRENTS OF HIGH INTENSITY IN A TOROIDAL DISCHARGE. Drees, J.; Trinks, H. W. (Univ., Bonn). Z. Phys., 200: 410-18(Mar. 14, 1967). (In German).

Intensive currents of runaway electrons with energies of 50 keV or more have been observed at high pressures in a plasma betatron in addition to betatron accelerated electrons at lower pressures. The measurements agree with the assumption that these electrons are accelerated in the external field while they are guided by the self magnetic field of the plasma current. Macroscopic instabilities and plasma waves can be excluded as accelerating mechanisms. The strong dependence of the runaway flux upon the gas pressure and the electric field can be explained by collisions between electrons and the other plasma particles. Furthermore the influence of the external magnetic field on the movement of the plasma current to the torus wall was investigated. A maximum circulating runaway current of more than 2000 A (Xenon) appeared when the plasma current was kept approximately in balance by the external magnetic field. (auth)

20972 PARAMETRIC COUPLING BETWEEN ION WAVES AND ELECTROMAGNETIC WAVES. Sjoelund, A. (Royal Inst. of Tech., Stockholm); Stenflo, L. Appl. Phys. Lett., 10: 201-2 (Apr. 1, 1967).

Parametric coupling between longitudinal ion waves and transverse electromagnetic waves in a plasma is studied. The possibilities of exciting ion waves and electron waves by means of this coupling mechanism are considered, and the growth rates are compared. (auth)

20973 VARIOUS PROPERTIES OF THE PLASMA JET IN THE MAGNETIC FIELD AT LOW PRESSURE. Okada, Minoru; Uchida, Masayoshi. Technol. Rep. Osaka Univ., 16: 471-83 (Oct. 1966).

Argon plasma was ejected continuously into a magnetic field along a coaxial direction of two magnetic coils at a low pressure atmosphere. The effects of cusp- or mirror-type magnetic fields on the plasma stream were investigated. Total pressure, flow speed, electron temperature, and heat flow intensity of the plasma were noticeably affected by the magnetic field. The shape and brightness were also variable with the magnetic fields. (auth)

20974 DERIVATION AND ANALYSIS OF A KINETIC EQUATION FOR A THREE-DIMENSIONAL HOMOGENEOUS SYSTEM WITH COLLECTIVE INTERACTIONS. II. Bessenrodt, R. (Technische Hochschule, Hanover). Ann. Phys. (7), 19: 128-43 (1967). (In German).

Following earlier work the second equation of the BBGKY hierarchy is solved approximately for thermodynamic equilibrium by transforming it into a differential equation and fitting its asymptotic solutions. The resultant pair correlation is used to correct the equations of state of the ideal gas and the mean square of the electric microfield on a plasma particle. Next, kinetic equations for multicomponent systems are established and applied to study the relative importance of the contributions of the Fokker–Planck coefficients, the pair correlations, viscosity, and heat conductivity of the fully ionized hydrogen plasma. Finally the interaction of two components with a nonvanishing drift velocity are calculated. (auth)

20975 PLASMA ELECTRON BEAM OF VERY HIGH CURRENT. Arata, Yoshiaki; Tomie, Michio; Katayama, Yasuo. Technol. Rep. Osaka Univ., 16: 485-94(Oct. 1966).

A linear electric-discharge accelerator which accelerates runaway electrons in plasma, and produces very high-current electron beams (100 ~ 500 kV, $10^3 \sim 5 \times 10^3$ A, <1 μsec is described. The interaction of the beam with some kinds of magnetic fields such as flat, bell, mirror, and cusp types, and the characteristics of the beam-generated x rays with very high dose were investigated. It was proved that such x ray source was useful for the study of a property of matter and nondestructive inspection, etc. (auth)

20976 PROPAGATION OF SYMMETRICAL WAVES IN A CYLINDRICAL WAVEGUIDE FILLED WITH NONUNIFORM PLASMA. Kartashev, V. G.; Shevchenko, R. F. (Moscow State Univ.). Radiotekh. Elektron., 11: 1413-18(Aug. 1966). (In Russian).

Propagation of symmetric electromagnetic waves in a cylindrical waveguide filled with plasma whose dielectric penetrability varied along the radius according to the square law was studied. A method is offered for calculating the differential equation eigenvalues for symmetric waves. The method was used for computing and constructing H_{01} and E_{01} dispersion curves. (tr-auth)

20977 EXCITATION OF ELECTRO-ACOUSTIC LATERAL WAVES IN A COMPRESSIBLE PLASMA BY A NON-ELECTROMAGNETIC SOURCE. Samaddar, S. N. (Raytheon Co., Sudbury, Mass.). Ann. Phys. (7), 19: 172-85(1967).

The possibility of excitation of lateral waves in a hot plasma in contact with a perfectly conducting boundary by a mechanical body source is considered. These lateral waves being incident on the conducting surface at a critical angle from the source travel a certain distance along the surface with the phase velocity of light in a cold plasma and the waves are then reflected back at the critical angle to the observer in the compressible plasma. The incident and reflected portions of the path are traversed by the waves with the phase velocity of an acoustic wave in a compressible plasma. It is shown that these electro-acoustic lateral waves can be excited also by an electric dipole oriented in the same direction as the mechanical body source. The amplitudes of the waves excited by these two different sources are compared. (auth)

20978 INVESTIGATION OF ALFVEN WAVES IN A PLASMA-FILLED WAVE GUIDE. Kaeppeler, H. J.; Mueller, G.; Raeuchle, E.; Schueller, P. G. (Technische Hochschule, Stuttgart). 19p. (CONF-661041-2). DTIE.

From 1st European Conference on Controlled Fusion and Plasma Physics, Munich.

The propagation of torsional Alfvén waves in a current-carrying nonuniform hydrogen plasma was investigated. The influence of the ions and neutral atoms, and density inhomogeneity of the plasma on phase velocity and wave attenuation was considered. The variation of density over the cross section results in a nonuniform distribution of the phase velocity. Comparison of experimental results with theoretical prediction shows good agreement. (auth)

20979 DISCUSSION OF THE TRANSMISSION AND REFLECTION BEHAVIOR OF ELECTROMAGNETIC WAVES AT MILLIMETER WAVELENGTHS IN HOMOGENEOUS PLASMA SHEATHS. Makios, W. (Institut fuer Plasmaphysik, Garching, Ger.). 15p. (CONF-660448-6). DTIE.

From Meeting of the Professional Group on Plasma and Gas Discharge Physics, Kiel.

The complex reflection and transmission coefficients of a plane homogeneous plasma slab were calculated to provide a basis for measuring the electron density and electron collision frequency in plasmas. The results obtained here for the reflection coefficient are different from those of previous calculations. These results were confirmed in detail by experimental investigations. (auth)

Production of Plasma

Refer also to abstract 19821.

20980 CALCULATIONS OF ARC COLUMN IN HYDROGEN AND AIR ATMOSPHERE. Krinberg, I. A. (Inst. of Geochemistry, Irkutsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 22-6(1966). (In Russian).

An electric arc model with longitudinal gas blowout is described. The generalized volt-ampere characteristics of the arc column for helium, nitrogen, hydrogen, and air were calculated at various pressures. The parameters of the jet in an electric arc heater were calculated, e.g., at $G = 5 \times 10^{-3}$ kg/sec, $d = 5 \times 10^{-3}$ m, $P = 10^5$ n/m^2 $d_c/d = \frac{1}{2}$ (where G is the mass flow, d is the diameter of the cylindrical electrode with the heat gas flow, P is the pressure, and d_c is the cathode diameter). The diagram of voltage and temperature distribution along the arc axis at various currents shows that at low currents the volt-ampere characteristics drop and at high currents they rise slightly. The model of the arc with longitudinal blowout enabled determination of the basic parameters of the arc by a computation method, and the results proved to be in agreement with experimental data. (R.V.J.)

20981 HIGH-FREQUENCY PLASMA DEVICE. Donskoi, A. V.; Dresvin, S. V.; Gol'dfarb, V. M. (Kalinin Polytechnical Inst., Leningrad). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 73-80(1966). (In Russian).

Even though the plasma torch is one of the best-investigated high-frequency electrothermic devices, its electric and energetic parameters are not sufficiently well known. These parameters were therefore studied, using a high-frequency generator operated at frequencies within the range from 5 to 8 megahertz to 10^8 to 10^9 hertz. With an applied potential of a few kilovolts, a current of 400 to 700 milliamp was obtained with a ballast resistance of about 10^4 ohm. A high-frequency torch operated with an electrodeless inductive discharge was also examined. Results obtained with both types indicated that the hot and cold portions of the jet should not be intermixed in high-frequency plasma torches. An effective cooling of the wall ensured the intensive recombination of the charged particles in the gap, preventing the formation of a shunting current. The high-frequency argon plasma torch with a water-cooled metallic chamber was operated at a power rating of 8 kW at atmospheric pressure, with a gas flow rate of 60 liters/min. (TTT)

20982 A THREE-PHASE, AC PLASMATRON. Rutberg, F. G.; Kiselev, A. A.; Dolyuk, V. A. Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 98-103(1966). (In Russian).

Three-phase ac plasmatrons used for creating low-temperature plasma are of much simpler construction than the corresponding dc machines. In all types, the gas is supplied axially from the periphery, preheating it as it passes through a spiral channel, stabilizing the arc at the superposition of the axial and tangential streams. The power rating of the arc did not exceed 50 kW; it was supplied from a 220- or 380-V line. The tests were carried out in argon, nitrogen, hydrogen, and helium for periods up to 15 minutes; the pressure within the chamber was kept between 1.5 and 15 atm. The lowest stable current at which the plasmatrons operated in a stable manner amounted to 80 amp.; the highest current was 520 amp., with current densities of 660 amp./cm^2. Eight- to 10-mm-diameter tungsten electrodes were used for the experiments. Water and turbulent working gas were used to cool the body of the device and the electrodes. It was found that an increase of pressure in the chamber modifies markedly the arc potential. The utilization coefficient of the arc, i.e., the ratio of the enthalpy of the gas and of the supplied power, was found to be 0.6 to 0.7 when argon and nitrogen were used. (TTT)

20983 CERTAIN EFFECTS OBSERVED IN THE STUDY OF AN ELECTRIC ARC IN A GAS STREAM. Baranov, V. Yu. (Lenin All-Union Electrotechnical Inst., USSR). Teplofiz. Vysok. Temp., 4: 621-4(Sept.-Oct. 1966). (In Russian).

A continuation is presented of earlier work devoted to the use of an arc as a preliminary ionizer of a magnetohydrodynamic generator. The purpose of the present investigation was to elucidate the physical processes that accompany the flow of electric current through a stream of neutral and ionized gas. An electric arc placed transverse to the motion of the gas was investigated in both decelerating and accelerating magnetic fields. The apparatus was the same as described in the earlier paper. The measurements yielded the distribution of the electrons in an argon-cesium plasma at different stream velocities when two arcs are used, the first serving as a pre-ionizer for the second. The results show that in the presence of preliminary ionization, the distribution of the concentrations of the arc in the gas stream becomes homogeneous and constant in time, and the arc channel diameter increases. Application of a magnetic field of a prescribed value leads to a more uniform distribution of the current, but owing to constriction of the arc diameter it may affect adversely the ionizing ability of the arc. (ATD)

20984 STUDY OF ELECTRIC-ARC BEHAVIOR WITH SUPERIMPOSED FLOW. Wutzke, S. A.; Pfender, E.; Eckert, E. R. G. (Univ. of Minnesota, Minneapolis). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 707-14(Apr. 1967).

The symptomatic behavior of an electric arc with a superimposed subsonic flow of argon is studied experimentally in an arc-tunnel facility with both plane and cylindrical anode geometries. Three arc modes are observed and described: the steady mode, the restrike mode, and the takeover mode. No voltage fluctuations are observed with the steady mode, whereas the restrike mode is characterized by sawtooth-shaped fluctuations, and the takeover mode exhibits more or less sinusoidal voltage fluctuations. High-speed photography combined with voltage-current information from a plane, segmented anode permits a detailed examination of these electrode phenomena. All three arc modes are observed with each of the anode geometries. Particular attention is given to the effect each mode has on the anode heat transfer, and a number of anode energy balances are established. The results show that the restrike mode may lead to a considerable lessening of the specific time-averaged heat flux to the anode and can mean the difference between anode integrity or failure. In addition, a temperature distribution in the cathode column is determined spectrometrically for one set of arc parameters. (auth)

20985 INVESTIGATION OF ELECTRIC BREAKDOWN IN AIR IN A TRANSVERSAL ELECTRIC FIELD. Nagornykh, Yu. D. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 102-4(July-Aug. 1966). (In Russian).

Following up previous studies on the electrical breakdown in transversal magnetic field in coaxial geometry, the phenomenon was examined using plane-parallel electrodes in air at pressures between 650 and 5×10^{-3} mm of Hg, gaps between electrodes ranging from 1 to 140 mm and magnetic induction from 0 to 10,600 gauss. The discharge chamber and the electrodes were made of glass and copper, respectively. The goal of the study was to determine the dependence of the breakdown potential on the pressure between the electrodes and the magnetic field potential at various interelectrode distances. The results indicated that in air the breakdown potential U_*^+ does not depend on these parameters. In the pressure range below 0.7 mm of Hg, the method of applying

the voltage appeared to affect strongly the U_s^+ values: use of condensers yielded higher breakdown potential values but at higher pressures the difference disappeared. (TTT)

20986 PRODUCTION OF SERIES LIMIT CONTINUA WITH THE HELP OF A GLIDE SPARKS FOR ABSOLUTE MEASUREMENT IN THE VACUUM ULTRAVIOLET. Conrads, Hans (Kernforschungsanlage, Juelich, Ger.). Z. Phys., 200: 444-55 (Mar. 14, 1967). (In German).

A lithium plasma is produced by discharging a 40-kV, 0.3-μF capacitor through a lithium-hydride-capillary (diameter 2 mm, length 20 mm) in vacuum ($p \sim 10^{-4}$ torr). During the first half-cycle (0.6 μs) bremsstrahlung of Li III is observed in the visible and infrared, and the Lyman series of Li III together with the recombination continuum in the vacuum uv (100 Å). The high members of the Lyman series are broadened by Stark effect giving an electron density of about 6×10^{18} cm^{-3}. In the infrared the radiation is emitted from an optically thick plasma at a time when the free–free continuum in the visible is emitted from an optically thin plasma. Temporal development of electron temperature T_e and electron density N_e has been measured from the absolute intensity in these spectral regions. Typical values of $T_e = 230{,}000$°K and N_e 5×10^{18} cm^{-3}, e.g., have been obtained. For these values the relaxation time for an ionization equilibrium is short compared to the observation time. The complete ionization of Li III has been checked by absorption measurements near 100 A. Thus the absolute intensity of the recombination continuum could be calculated. An experimental arrangement was built to measure simultaneously the time history of the intensity in the ultraviolet, in the visible, and infrared spectral regions. (auth)

20987 PRODUCTION OF COMPLETELY IONIZED PLASMA. (to U. S. Atomic Energy Commission). British Patent 1,064,710. Apr. 5, 1967. Priority date Dec. 11, 1964, United States.

A device for producing a substantially completely ionized, high-energy plasma for producing neutrons is described. It comprises an evacuated enclosure between a heated electron emissive cathode and a gas-fed cylindrical anode enclosing the space between a pair of annular, energized magnetic mirror coils spaced apart about 22 inches and having a mirror ratio of about 2 to 1. (M.H.R.)

Stability of Plasma

Refer also to abstract 20943.

20988 (MATT-Q-23, pp 181-320) THEORY. (Princeton Univ., N. J. Plasma Physics Lab.).

Discussions and conclusions are presented for the following: kinetic structure of a plasma, higher order corrections to the Chew–Goldberger–Low theory, a model for steady nonlinear ion-wave instabilities, exact invariants for the Korteweg–deVries equation, maximal ordering stability problem, the effect of viscosity on the resistive gravitational instability, the resistive ballooning mode with shear, special topics concerning universal-type instabilities, a remark on the relation between the Kelvin–Helmholtz instability and the resistive drift instabilities, gravity-driven instability in a hot electron plasma, excitation of electrostatic ion cyclotron oscillations, negative V stellarators, hydromagnetic stability in closed line geometry, stability of negative V systems, effect of pressure on negative V stellarators, is the stellarator a minimum B system, radiative equilibrium of a free electron gas in a uniform magnetic field, quantum particle orbit theory of a free electron gas in a uniform magnetic field, and calculations of the drifts and of the plasma losses in Q devices with curved magnetic fields. In addition, abstracts of other papers on the subjects are included. (M.O.W.)

20989 (ORO-3405-15) MODE SYNCHRONIZATION PHENOMENA IN UNIVERSAL PLASMA INSTABILITIES. Lashinsky, Herbert (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Jan. 1967. Contract AT(40-1)-3405. 17p. (CONF-670104-7; BN-487). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Physics of Quiescent Plasmas, Frascati, Italy.

Recent work indicates that a model based on an ensemble of weakly coupled Van der Pol oscillators is capable of describing a variety of experimental phenomena that have been observed in Q machines. This model is used to investigate the transition to turbulence in a thermal plasma device. It has been observed experimentally that, at the threshold of instability, the system exhibits a locked-mode spectrum with narrow spectral lines, in which the modes maintain fixed phase relations with respect to each other. It is shown that a given mode can be synchronized by a perturbation at a close-lying frequency if the frequency deviation is small enough and if the amplitude of the perturbation is large enough. The question as to how a plasma instability in a bounded system, characterized by discrete nodes, can eventually give rise to the continuous noise spectrum characteristic of the turbulent state that is observed in the Q machine is discussed. (M.O.W.)

20990 CHERENKOV AND CYCLOTRON INSTABILITIES IN A PLASMA STREAM. Knox, C. F. (Cavendish Lab., Cambridge, Eng.). J. Plasma Phys., Pt. 1, 1: 1-27(Feb. 1967).

The model of a stationary medium traversed by a weak plasma stream directed along a magnetic field is investigated. The usual linear treatment is adopted, and the stream is taken to be "cold," with only electron (perturbation) motions considered. The objective is to assess the plane-wave growth associated with both Cherenkov and cyclotron instabilities; in particular, the dependence of the growth on frequency and angle of phase propagation. The main discussion is of the case when the stationary medium is a cold plasma in which both electron and positive ion motions are taken into account. Various expressions for the growth are derived, and numerical calculations are presented in graphical form. (auth)

20991 FORMATION OF CURRENT IN AN ELECTROMAGNETIC SHOCK TUBE. Makarevich, G. A.; Shimarev, S. K. Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 86-90(1966). (In Russian).

Electromagnetic shock tubes make it possible to reach shock wave velocities exceeding those obtainable with ordinary shock tubes. Suitability of these tubes for physical and aerodynamics calculations depends on the dimensions of the homogeneous, thermally ionized plasma between the shock wave front and the frontal portion of the plasma ejected from the discharge chamber. Three different types of discharge chambers with efficiencies between 50 and 60%, were examined. It was found that whenever a metallic section was used, the velocity of the shock wave increased; this might be due to the decrease of the energy discharge losses, resulting from the high conductivity of the metal with respect to that of the plasma. The metal was also found to exert a stabilizing influence on the creation of plasma jet instabilities. The grating used for reducing the zone of formation and for weakening the effect of magnetic acceleration in the current was found to reduce the current velocity. It also contributed to the development of flow instabilities. The metallic and dielectric gratings did not exhibit any difference in their action on the current. Forming of the current in electromagnetic shock tubes must be further studied. (TTT)

20992 INVESTIGATION OF STABILIZED ANNULAR DISCHARGE IN ARGON. Alad'ev, I. T.; Kulakov, I. G.; Magdasiev, O. L.; Shatilov, A. P. (Krzhizhanovskii Energetics Inst., Moscow). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 50-6(1966). (In Russian).

Electrodeless vortex-stabilized discharges which are stable at discharge chamber ratings of a few kilowatt were found to make it possible for one to reach gas temperatures up to 10,000°K and to decrease the contamination of the gas by impurities. This phenomenon was examined in a quartz discharge chamber, in which stabilized discharge experiments were carried out at 1 atm. pressure in argon. Up to a certain flow rate of the gas, the high-frequency discharge exhibited the pinch effect and remained stable. The tests were carried out at flow rates of 0.44, 0.64, and 1.15 g/sec of argon. Study of the axial temperature distribution within the discharge chamber revealed that the highest temperature, 9750°K, was reached at the center of the inductor where the diameter of the plasma pinch was about 40 mm. The dynamic pressure distribution in the axial direction revealed a maximum of 60 mm of water. At the edges of the discharge chamber, negative pressure values were obtained; they were probably due to vortex formation in the gas stream during stabilization. (TTT)

20993 A CALCULATION METHOD FOR THE OPERATING PARAMETERS, UNDER CONSIDERATION OF GAS-DYNAMIC FACTORS, AND DETERMINATION OF THE FUNDAMENTAL DIMENSIONS OF AN ELECTRIC-ARC GENERATOR WITH VORTEX GAS STABILIZATION OF THE ARC. Voronin, B. D.; Tsirlin, A. M.; Smelyanskii, M. Ya. Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 57-65(1966). (In Russian).

In spite of the considerable amount of experimental material available on the vortex gas stabilization of the arc used for plasma jet, no calculation methods have been as yet developed for these devices. The high-voltage electric-arc apparatus operating in hydrogen at relatively low currents do not follow the anticipated volt–ampere characteristics. Therefore, the effect of some fundamental factors, such as current, gas flow rate, and geometric dimensions on the condition of stabilization were investigated, intending to determine the limits of stable

operation and to derive quantitative relationships. A calculation method was derived for correlating these operational parameters with the basic geometric dimensions of the system; on the basis of these results a 1000-kW electric-arc heating device for hydrogen was designed; it is expected that operation of this device will result in a more precise determination of the constants of the equations and of the fundamental geometrical relationships. (TTT)

20994 BEHAVIOR AND STABILITY OF AN ELECTRON PLASMA IN THE PRESENCE OF A TIME-DEPENDENT ELECTRIC FIELD. Brambilla, Marco; Canobbio, Ernesto (CEN, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 264: 28-30(Jan. 4, 1967). (In French).

The problem of the stability of an electron plasma in a uniform magnetic field in the presence of a time-dependent electric field $\vec{E}(t)$ is resolved in reduction to the case where $\vec{E}(t) = 0$. (tr-auth)

20995 MAGNETOHYDRODYNAMIC PHENOMENA IN THE ELECTRIC ARC. Serdyuk, G. B. Magnit. Gidrodin., No. 4, 136-46(1966). (In Russian).

Magnetohydrodynamic phenomena in an open electric arc and their role in plasma configurations are considered. Estimates are given for the role of an electric arc plasma flow in plasma instability of various kinds and the character of the arc behavior in the presence of a magnetic field. (auth)

20996 QUASILINEAR THEORY OF TWO-BEAM INSTABILITY. Shut'ko, A. V. Dokl. Akad. Nauk SSSR, 171: 1076-9 (Dec. 11, 1966). (In Russian).

In view of the fact that the standard procedure of separating the resonant particles cannot be used for analysis of the instability of monoenergetic plasma beams, the authors consider a simple physical model, which is definitely related to two-stream instability, and for which simple and exact quasilinear stability equations can be derived. The averaged electron distribution function and the potential-pulsation intensity are determined for a stationary electron plasma which is homogeneous in the mean, and a solution is obtained for this system of equations in terms of the velocity, the time, the electron mass, and the electron charge. The results show, for the case of a single plasma beam, that the field-energy density is small compared with the beam energy, so that the quasi-linear approximation can be employed. The reason for the smallness is that the bulk of the beam energy goes to the electrons, so that there is little left to give up to the field. The procedure can be applied to electron beams of different intensities and to the instability of a system consisting of an electron and ion beam. Certain limitations of the approach are discussed. (ATD)

20997 TEMPERATURE DRIFT INSTABILITY OF A PLASMA WITH CROSSED FIELD LINES. Pogutse, O. P. Zh. Eksp. Teor. Fiz., 52: 759-67(Mar. 1967). (In Russian).

A linear theory of temperature drift instability is considered. It is shown that classification of instabilities can be simplified by introducing a relatively strong crossing of the lines of force which also permits one to separate out the most large-scale temperature drift instability. The region of localization, local increments and frequency are found for the latter. The case $T_i \ll T_e$ is considered in detail. Conditions for stabilization by crossed field lines are determined for a maximal turbulent transfer coefficient. (auth)

Shielding

Refer also to abstracts 20737, 21361, 21366, 21373–21377, 21401, and 21442.

20998 (FFA-673) A PRELIMINARY USER'S MANUAL FOR THE NRN SHIELD DESIGN METHOD IN FORTRAN IV LANGUAGE. Nyman, Kj.; Olsson, Kj.; Aalto, E.; Lindblom, K.; Malen, K.; Olsson, G. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Nov. 10, 1965. 72p. (RFN-213). Dep. mn.

A preliminary version of the user's manual of the NRN shield design method in FORTRAN IV language is presented. The codes described are: Data preparation code NECO; Multigroup removal codes REBOX for box geometry and REMC for spherical and cylindrical geometries; and Multigroup diffusion- and slowing-down code NEDI. The aim wher preparing the NRN method was to decrease and simplify the amount of manual input to a minimum by connecting the inputs and outputs of the codes. The nonrigorous removal–diffusion method with suitably optimized programs leads to relatively short running times, a typical first run of a problem (including a data preparation run) taking ~⅓ h and repeated runs with a ready macroscopic data tape 10 to 15 minutes. Some of the detailed running instructions in the manual refer to an IBM 7044 computer, but the codes are wholly in the FORTRAN IV language. (auth)

20999 (N-66-27941) MONTE CARLO CALCULATIONS OF ENERGY DEPOSITIONS AND RADIATION TRANSPORT. VOLUME 1. VALIDATION OF COHORT CODES. Collins, D. G.; DeVries, T. W. (General Dynamics/Fort Worth, Tex.). Dec. 21, 1963. Contract NAS8-5182. 31p. (NASA-CR-75629; FZK-176-1). CFSTI $3.00 cy, $0.65 mn.

A Monte Carlo procedure for the IBM 7090 digital computer was developed to perform calculations of the radiation heating in propellant tanks and the radiation environment about a nuclear rocket stage. The procedure is made up of seven codes. These codes generate primary-source-particle parameters, neutron and gamma histories, and secondary gamma source parameters. The codes will also analyze the history data so that the particular quantities desired as answers to a given problem may be determined. The results from the Monte Carlo codes are compared with other calculations of the heat deposition in liquid hydrogen and with calculations and measurements of the angular distribution of a fast-neutron dose rate transmitted through a 9-inch polyethylene slab. Information reported includes sources of the cross-section data gathered in preparation for a flux leakage calculation from a NERVA-type engine. (auth)

21000 (ORNL-4093) ADJOINT AND IMPORTANCE IN MONTE CARLO APPLICATION. Coveyou, R. R.; Cain, V. R.; Yost, K. J. (Oak Ridge National Lab., Tenn.). Apr. 1967. Contract W-7405-eng-26. 64p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The use of the Monte Carlo method for the study of deep penetration of radiation into and through shields entails the use of sophisticated methods of variance reduction in order to make such calculations economical or even feasible. An exposition of the most useful methods of variance reduction is presented. The exposition is unified by consistent exploitation of adjoint formulations to estimate expected values, as in previous work, and further to evaluate the variance of the resulting estimates. The connection between adjoint formulations and the choice of biasing schemes is also investigated. In particular, it is shown that the value function (the solution of the integral equation of the adjoint formulation) is always a good choice for importance function biasing; a sharp upper bound, independent of the particular problem, is found for the resulting variance. Predicted (analytic) and experimental (Monte Carlo) results are also given for a simple one-dimensional problem. (auth)

21001 (ORNL-tr-1523) MEASUREMENT OF GAMMA RADIATION IN THE MOCKUP OF A POWER REACTOR SHIELD IN THE GEESTHACHT RESEARCH REACTOR (FRG). Futtermenger, W. Translated for Oak Ridge National Lab., Tenn., from report ABS-THH-1018. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $4.60 fs, $1.68 mf.

The measuring methods applied are described with their physical properties, detection limits and errors. The adjustment of power and radiation period to the space and time distribution of the detectors are discussed. Necessary corrections for the calculation of γ-dose values are included. All necessary corrections and total errors of the measurements are compiled. The results are discussed. (M.H.R.)

21002 DEEP PENETRATION OF RADIATION BY THE METHOD OF INVARIANT IMBEDDING. Mathews, D. R.; Hansen, K. F.; Mason, E. A. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 27: 263-70(Feb. 1967).

The method of invariant imbedding was applied to neutron shielding problems in plane geometry with realistic energy and angle-dependence cross sections. The method seems to offer advantages over competing methods when the shield is heterogeneous and very thick or when the shield is composed of a very large number of different regions. Reflection and transmission equations are derived by the method of invariant imbedding, and their numerical solution is discussed. A simple exponential approximation is shown to work well for the solution of these equations. Results for several problems including a thick homogeneous water shield and a thinner heterogeneous iron/polyethylene/iron shield are compared with results obtained by other methods. (auth)

21003 NEUTRON-ATTENUATION EXPERIMENTS IN IRON-WATER CONFIGURATIONS. Chinaglia, B. (SORIN, Saluggia, Italy); Monti, D.; Fedrighini, C.; Moncassoli, A. M. Nucl. Sci. Eng., 27: 308-17(Feb. 1967).

Fast-, epithermal-, and thermal-neutron penetration was measured in the ETNA facility (plane fission neutron source) for some simple shield configurations (all water or a composite of water, iron, and water slabs with iron thickness of 6.2, 10, and 19.6 cm). Experimental results are presented as thermal fluxes or activation-detector reaction rates for the water-only configuration and as the ratios of the reaction rates observed in the other configurations to those obtained with water only. These results are com-

pared to calculations performed with a multigroup-removal diffusion code (MAC-RAD) and a semi-empirical diffusion code (FOG-S) to test their ability to predict the influence of an iron slab on the neutron spectrum and the neutron attenuation. (auth)

21004 DEPENDENCE OF FAST NEUTRON BUILDUP FACTOR ON DETECTOR AND SHIELD POSITION. Degtyarev, S. F.; Kukhtevich, V. I.; Tikhonov, V. K.; Tsypin, S. G. At. Energ. (USSR), 21: 395-7(Nov. 1966). (In Russian).

The results of an experimental and theoretical investigation of the dependence of the fast neutron beam with energy $\gg 0.7$ Mev on the distance between target and detector with a constant distance between the source and target are reported. There is good agreement between the experimental and theoretical results. The buildup curve obtained leads to the conclusion that with the increase of the distance from the shield, the radiation scattering lengths in the complete neutron beam decrease. (tr-auth)

21005 PENETRATION OF γ RAYS THROUGH SPHERICAL AND CYLINDRICAL SHIELDS. Larichev, A. V.; Partolin, O. F.; Chistove, E. D.; Zaraev, O. M. At. Energ. (USSR), 21: 398-400 (Nov. 1966). (In Russian).

The results of the experimental study of the attenuation of γ radiation of the isotopes ^{60}Co, ^{137}Cs, ^{134}Cs, and ^{170}Tm in cylindrical and spherical shields are reported. The results are graphed for various thicknesses of W, Pb, Fe, and Al shields. It was determined that attenuation efficiency for the cylindrical form is greater than that of the plane form but less than that of the spherical form. With decrease of the energy of the γ radiation and of the atomic number of the shield material, the attenuation multiplicity of the spherical and cylindrical shields increases. (J.S.R.)

21006 COMPUTATION OF PHOTOELECTRIC COEFFICIENTS OF γ ATTENUATION. Marenkov, O. S. At. Energ. (USSR), 21: 389(Nov. 1966). (In Russian).

The results of an analytical approximation of the mass photoelectric coefficients of γ radiation attenuation using the least squares method with utilization of the weight functions, are reported for the elements and materials Be, C, N, O, Na, Mg, Al, Si, P, Ar, K, Ca, Fe, Cu, Mo, Sn, Pb, air, water, sand, and sodium iodide. (J.S.R.)

21007 CALCULATIONS OF THE RADIATION HAZARD DUE TO EXPOSURE OF SUPERSONIC AIRCRAFT TO SOLAR-FLARE PROTONS. Leimdorfer, M.; Alsmiller, R. G. Jr.; Boughner, R. T. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 27: 151-7(Feb. 1967). (ORNL-TM-1594).

Monte Carlo transport calculations were carried out to estimate the dose travelers in supersonic aircraft will receive from a typical spectrum of solar-flare protons. The dose, from both primary protons and secondary particles, as a function of depth in a tissue slab placed at various depths in the atmosphere, was obtained. The incident spectrum is broken into eight energy regions and the dose from the incident protons in each of these regions is presented. (auth)

21008 HIGH-ENERGY NUCLEON TRANSPORT AND SPACE VEHICLE SHIELDING. Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 27: 158-89(Feb. 1967). (ORNL-TM-1518).

Recent work on the transport of high-energy massive particles (protons, neutrons, alpha particles, etc.) through dense matter as it applies to the shielding of manned space vehicles is reviewed. The transport of heavy particles through tissue and the resultant physical dose (rad) is considered, but the important question of the biological effects of radiation is not discussed. Throughout the discussion an attempt is made to indicate the areas of uncertainty where further research is required and particularly to indicate the areas where experimental confirmation of theoretical results is needed. (auth)

21009 ADJOINT AND IMPORTANCE IN MONTE CARLO APPLICATION. Coveyou, R. R.; Cain, V. R.; Yost, K. J. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 27: 219-34 (Feb. 1967).

The use of the Monte Carlo method for the study of deep penetration of radiation into and through shields entails the use of sophisticated methods of variance reduction to make such calculations economical or even feasible. An exposition of the most useful methods of variance reduction is presented. The exposition is unified by consistent exploitation of adjoint formulations to estimate expected values, and further to evaluate the variance of the resulting estimates. The connection between adjoint formulations and the choice of biasing schemes is also investigated. In particular, it is shown that the value function (the solution of the integral equation of the adjoint formulation) is always a good choice for importance function biasing; a sharp upper bound, independent of the particular problem, is found for the resulting variance. Predicted (analytic) and experimental (Monte Carlo) results are also given for a simple one-dimensional problem. (auth)

21010 DOSES BEHIND VERTICAL AND HORIZONTAL BARRIERS FROM A PLANE SOURCE OF 1.25-MeV GAMMA-RAY PHOTONS. Raso, Dominic J.; Woolf, Stanley (Technical Operations Research, Burlington, Mass.). Nucl. Sci. Eng., 27: 252-62 (Feb. 1967).

Calculations were performed by the Monte Carlo method to determine the dose at various detector locations behind a vertical barrier and below an adjacent horizontal barrier. Results were obtained, using two different Monte Carlo approaches, for a 1.25-MeV simulated ground source incident on 60, 40, and 20 psf of concrete. The results of the Monte Carlo calculations were used to calculate reduction factors. The above-ground reduction factors compared with those of Spencer to within 10%. The below-ground reduction factors were compared with those calculated from the OCD Engineering Manual, and the agreement in this case was found to be unsatisfactory. In some instances, discrepancies were found to be as high as a factor of 3. For the case of the open basement, agreement among the three methods was found to lie within 10 to 20%. The results obtained by the two Monte Carlo methods used were found to be in excellent agreement. These results also compared to within 10 to 15% with results of experiments performed at Technical Operations Research. The results indicate that further investigation is necessary to determine the amount of scattered radiation within a basement. (auth)

21011 CAPTURE AND FISSION GAMMA-RAY EFFECTIVE SPECTRA FOR SHIELDING. Dudziak, Donald J. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 27: 328-37(Feb. 1967). (LA-DC-8253).

Effective two-group gamma spectra were determined for thermal-neutron capture in sodium, nickel, type-304 stainless steel, and tantalum, as well as for ^{235}U prompt-fission gamma rays. A seven-group compilation of capture gamma rays was used as the basis for this study. Absorbed dose (uncollided and builtup) in several materials was calculated for varying thicknesses of several intervening shielding materials. The resulting function for each combination was reduced to two exponential functions over a range of 0 up to 560 g/cm^2. Effective spectra were determined. These effective spectra reproduce, to within an average absolute deviation of less than 7.4%, the absorbed doses (uncollided and builtup) calculated by the detailed spectra, within the ranges of areal density considered. (auth)

21012 HIGH-ENERGY ACCELERATOR SHIELD-LEAKAGE NEUTRON SPECTRA. O'Brien, Keran; Sanna, Robert; Alberg, Mary; McLaughlin, James E.; Rothenberg, Sam A. (Atomic Energy Commission, New York). Nucl. Sci. Eng., 27: 338-47 (Feb. 1967).

Measurements with nuclear track emulsions at several synchrotrons and calculations of the low-energy neutron cascade show that the neutron spectrum transmitted through high-energy accelerator shields depends on shield thickness and water content. Calculated and measured spectra show the same general behavior and dependence. Experimental data by other workers are in agreement with results presented. (auth)

21013 AN ANALYSIS OF A SHIELDING EXPERIMENT PERFORMED IN A REAL FALLOUT FIELD. French, R. L.; Price, J. H.; Tompkins, K. W. Contract DA-23-072-AMC-332(X). Nucl. Sci. Eng., 27: 360-6(Feb. 1967).

Four simple enclosure shields were exposed to fallout from Shot Small Boy of Operation Sunbeam. Gamma-ray measurements were made both inside and outside the enclosures to determine time-dependent and time-integrated dose transmission factors (dose inside divided by dose outside). The analysis of the experiment consisted of calculating similar factors and comparing with the measured data. Monte Carlo procedures were used to determine the radiation distribution incident upon the shields and to compute the radiation penetration into the shields. Fallout gamma spectra resulting from several different theoretical and experimental investigations were used in calculating the dose transmission factors. The calculated dose transmission factors were found to be consistently higher than the measured factors by as much as a factor of 2, depending upon the particular source term. After investigating several possible causes, it was concluded that the discrepancy was probably the cumulative effect of a deficiency of low-energy photons in the calculated source terms, omission of support structure inside the enclosure shields in the penetration calculations, and of neglecting the effects of ground roughness in the calculations. (auth)

21014 ALBEDO COMPONENT OF GAMMA RAYS PASSING THROUGH A CYLINDRICAL DUCT. Higashihara, Y. (Kawasaki

Dockyard Co., Ltd., Tokyo); Nakai, Masaru; Okubo, Masanori. Nucl. Sci. Eng., 27: 441-9 (Feb. 1967).

The albedo component of gamma rays passing through a straight cylindrical lead duct has been investigated experimentally for reactor leakage gamma rays impinging on the duct mouth at various angles of 0 through 90°. The distribution of the albedo component along the duct axis may be expressed in the form $F(\alpha) \times (Z/A)^{-3}$ within the range of Z/A investigated. The contributions from multiple-reflection components to total dose have also been inferred. Also obtained were the radial distributions in both horizontal and vertical directions within and behind the duct. For a duct with one bend of 90°, the gamma-ray dose contributions arising from scattering areas located in both the first leg and the second leg have been determined separately for the incident beam angle of 0° with respect to the axis of the first leg. (auth)

21015 EMPIRICAL FORMULAS FOR SECONDARY-NUCLEON-PRODUCTION CROSS SECTIONS. Yucker, W. R. (Douglas Aircraft Co., Santa Monica, Calif.). Nucl. Sci. Eng., 27: 467-8 (Feb. 1967).

Cross sections for the production of secondary nucleons by high-energy nucleons incident on various nuclei were analyzed for application to shielding calculations. Formulas derived from both experimental data and Monte Carlo calculations are presented for nonelastic cross sections, cascade yields, average residual nuclear excitations, evaporation yields, and secondary-particle energy spectra. (D.C.W.)

21016 DIFFERENTIAL NEUTRON ALBEDO FOR FINITE SLABS. Doty, Duane R. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Nucl. Sci. Eng., 27: 478-81 (Feb. 1967).

The differential albedos for thermal neutrons incident on slabs of Al, Fe, and polyethylene were measured at various angles as a function of slab thickness for Al and Fe and as a function of the backscattering angle for slabs of Al and polyethylene of various thicknesses. An approximate formula for thermal-neutron differential albedo was derived. The experimental results were compared with the predictions of the approximate formula and of more accurate calculations. (D.C.W.)

21017 A MODIFIED FORMULA FOR DIFFERENTIAL EXPOSURE ALBEDO FOR GAMMA RAYS REFLECTED FROM CONCRETE. Chilton, A. B. (Univ. of Illinois, Urbana). Nucl. Sci. Eng., 27: 481-2 (Feb. 1967).

A formula for differential albedo is presented which is useful for hand calculation or as a reasonably accurate method of inserting albedo information into a computer program without the need for large amounts of tabulated data. (M.H.R.)

21018 AIR-GROUND INTERFACE EFFECTS ON THE EXPOSURE FROM ELEVATED ^{137}Cs γ SOURCES. Clifford, C. E.; Walt, G. D. (Defence Research Board, Ottawa). Nucl. Sci. Eng., 27: 483-5 (Feb. 1967).

Questions have been raised about the effect of elevated sources on the exposure in a contamination field and about the interpretation of measurements obtained in an aerial radiological survey over a foliated area. To aid in answering these questions, a study was made of the air–ground correction factors for point isotropic gamma sources at source heights likely to be of interest for foliar retention problems. It appears that infinite medium calculations of the exposure dose in air, or air-like materials, can be applied to problems involving elevated, uniformly distributed gamma sources without introducing large errors. (M.H.R.)

21019 ELECTRON TRANSPORT THEORY, CALCULATIONS, AND EXPERIMENTS. Zerby, C. D.; Keller, F. L. (Space Sciences and Engineering Lab., White Plains, N. Y.). Nucl. Sci. Eng., 27: 190-218 (Feb. 1967).

A review of the state-of-the-art of electron transport theory and calculations for electrons in the energy range below 10 MeV is presented. The basic interactions that influence the behavior of electrons are reviewed and theory and experimental results are compared wherever possible. The continuous slowing down model, the straggling model, and multiple scattering models are discussed and their use in thick-target moments method and Monte Carlo calculations is described. Results of the thick-target calculations are also compared with experimental results. Included in the review is a detailed description of the various complex-geometry electron transport programs presently being used. (auth)

21020 A STUDY OF THE ANGULAR AND ENERGY DISTRIBUTIONS OF RADIATION AT SMALL DISTANCES FROM A POINT SOURCE OF GAMMA RAYS OR NEUTRONS. Eisenhauer, Charles (National Bureau of Standards, Washington, D. C.). Nucl. Sci. Eng., 27: 240-51 (Feb. 1967).

The theoretical expression for the singly scattered angular and energy flux of radiation from a point source is studied in the limit of very small source-detector separation distances ($\mu_0 r \ll 1$). It is shown that both the angular and energy distributions are related in a simple way to the scattering kernel. Examples are given for gamma and neutron point sources in air. The applicability of the distributions at separation distances of the order of a mean free path ($\mu_0 r \approx 1$) is discussed. (auth)

21021 EXPERIMENTAL DIFFERENTIAL NUMBER, ENERGY AND EXPOSURE ALBEDOS FOR SEMI-INFINITE MEDIA, FOR NORMALLY INCIDENT GAMMA PHOTONS. Steyn, J. J. (NUS Corp., Washington, D. C.); Andrews, D. G. Nucl. Sci. Eng., 27: 318-27 (Feb. 1967).

Differential angular and energy distributions of backscattered gamma rays have been measured for photons normally incident on essentially semi-infinite scattering media of various atomic numbers. The measurements have been made by permitting a highly collimated 3- × 3-in. sodium-iodide (thallium-activated) scintillation crystal to view a sample area at the center of a scattering slab region irradiated by a broad beam of gamma radiation. The spectra have been recorded on a 400-channel pulse-height analyzer and reduced to detector incident flux by means of an IBM-7094 digital computer. The results were expressed graphically in terms of albedos and fitted to simple empirical expressions. In the case of high-atomic-number scatterers, K x-ray fluorescence has been separately evaluated. (auth)

21022 INVESTIGATION OF THE FLOOR-BARRIER REDUCTION FACTOR USED IN STRUCTURE SHIELDING THEORY. Kaplan, A. L. (Technical Operations Research, Burlington, Mass.). Nucl. Sci. Eng., 27: 388-93 (Feb. 1967).

Attenuation by a floor barrier of fallout gamma radiation scattered into a basement has been studied experimentally with cylindrical steel structures. These structures were 2-ft high, 2-ft in diameter, with a 4-ft-deep basement. Wall thicknesses varied between 5 and 60 psf, with floor thicknesses of 0, 10, 20, and 40 psf. Detectors in the basement were located between 0.25 and 3 ft below ground. Cobalt-60 point sources were used to simulate the fallout field. Basement reduction factors predicted by structure shielding theory were lower than the experimental results by a factor of between 1.5 and 8. This discrepancy was attributed to the theoretical floor-barrier reduction factor. A new theoretical floor-barrier reduction factor, which is a function of both the floor thickness and the solid-angle fraction subtended at the detector by the floor, was constructed within the formalism of the existing structure shielding theory. This new function agreed quite well with both experimental results and Monte Carlo calculations, over the entire range of wall and floor thicknesses used in the experiment. (auth)

21023 GAMMA-RAY SCATTERING NEAR AN AIR-GROUND INTERFACE. Clarke, E. T. (Technical Operations Research, Burlington, Mass.). Nucl. Sci. Eng., 27: 394-402 (Feb. 1967).

The status of experimental and theoretical gamma-radiation intensity at or near an air-ground interface is reviewed. Various measurements of radiation scattered to a detector 3 ft above an air-ground interface containing a point source of ^{60}Co or ^{137}Cs at various distances are compared with Monte Carlo data and moments method calculations for an infinite homogeneous air medium. Other measurements and calculations of skyshine radiation backscattered by the air under similar circumstances are also analyzed. It is shown that the three approaches—experimental, Monte Carlo, and moments method—produce consistent results for ^{60}Co. For an infinite plane source of ^{137}Cs, however, experimental measurements over ice and over concrete indicate about 20% less scattered radiation over concrete than would be received from the same source in an infinite homogeneous air medium. (auth)

21024 CLOSE-IN EXPOSURE FIELD FROM POINT ISOTROPIC GAMMA-RAY SOURCE LOCATED AT AN AIR-GROUND INTERFACE. Chilton, A. B. (Univ. of Illinois, Urbana). Nucl. Sci. Eng., 27: 403-10 (Feb. 1967).

On the basis of a simplified theoretical model and formulas, a method is presented for calculating the exposure field in the air near an air-ground interface on (or very near) which a point isotropic source of monoenergetic gamma rays has been placed. Necessary functions have been calculated and are presented for cobalt-60 (1.25 MeV) and cesium-137 (0.662 MeV). Within the limitations of the model, calculated results have an uncertainty on the order of 1%, for source-detector distances out to about 15 m. Comparison with previous experimental and theoretical results is made. At detector locations very near the source (on the order of a meter or less), the exposure field is somewhat affected by the exact height of the source above the interface, even for variations on the order of a centimeter. (auth)

21025 CALCULATION OF DOUBLY DIFFERENTIAL CURRENT ALBEDOS FOR EPICADMIUM NEUTRONS INCIDENT ON CONCRETE AND COMPARISON OF THE REFLECTED SUBCAD-

MIUM COMPONENT WITH EXPERIMENT. Coleman, W. A.; Maerker, R. E.; Muckenthaler, F. J.; Stevens, P. N. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 27: 411-22(Feb. 1967). (ORNL-TM-1554).

Extensive Monte Carlo calculations were performed to determine the distribution in energy and angle of neutrons reflected from steel-reinforced concrete for five incident directions and ten incident energy groups extending from 0.5 eV to 200 keV. The reflected distributions were determined in terms of a doubly differential albedo for each of 54 emergent directions for each energy group lying between and including the incident group and the tenth group (0.5 to 1.8 eV). The standard deviation of the doubly differential albedo averaged around ten percent. The angular slowing down density of the incident epicadmium neutrons within the slab was computed at 0.5 eV and was used as the source distribution for a Monte Carlo single-velocity diffusion calculation using 0.025-eV cross sections. From the diffusion calculation, the differential angular albedos of the reflected subcadmium neutrons and the depth distributions of captures occurring at subcadmium energies were obtained. Measurements of the differential angular albedo of emergent subcadmium neutrons due to a measured spectrum of incident monodirectional beams of epicadmium neutrons were performed at the ORNL Tower Shielding Facility in an experiment geometrically identical to that previously reported for incident subcadmium beams. Of the 35 common points of calculation and measurement, the two largest discrepancies are 23 and 36%; the remaining 33 comparisons produced a root-mean-square deviation of 4.5%. (auth)

21026 MONTE CARLO CALCULATIONS, USING THE ALBEDO CONCEPT, OF THE FAST-NEUTRON DOSE RATES ALONG THE CENTER LINES OF ONE- AND TWO-LEGGED SQUARE CONCRETE OPEN DUCTS AND COMPARISON WITH EXPERIMENT. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 27: 423-32(Feb. 1967). (ORNL-TM-1557).

Monte Carlo calculations have been carried out to determine the fast-neutron dose-rate distributions along the center lines of both a straight and a two-legged square concrete duct for a particularly demanding source geometry. The calculations incorporated doubly differential dose-albedo data for concrete which were previously reported. A comparison of the results of the calculations with those from a geometrically similar experiment shows good agreement, and places on a firm foundation the concept of treating the fast-neutron duct transmission problem as a reflection phenomenon at a point that is describable by the differential albedo properties of the walls. (auth)

21027 ATTENUATION OF NEUTRONS AND PHOTONS IN A DUCT FILLED WITH A HELICAL STEEL PLUG. Aalto, E.; Krell, A. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Sci. Eng., 27: 433-40(Feb. 1967).

Neutron and gamma-ray attenuation has been studied in a cylindrical duct, length-to-diameter ratio = 7, partly (36 vol%) filled by a helical (screw-like) steel plug with an adjustable number of turns. The total neutron leakage through the duct decreased by a factor of 6 when the number of turns increased from 0 to 0.5; and by an additional factor of 3 in going from 0.5 to 2 turns (saturation value). The leakage with less than 0.5 turns is governed by the fast flux and above 0.5 turns by the epithermal flux. It is shown that the neutron attenuation (in the saturated case) can be satisfactorily predicted by homogenizing the plug and by combining the attenuation calculated in an infinite layer thus obtained with that predicted in a circular duct. The prerequisite is that the attenuation curves obtained are displaced in the streaming direction by the diameter of the duct. The attenuation of gamma rays in the saturation case (≈3 turns) equals that predicted in a homogenized infinite material without the duct attenuation. (auth)

21028 GAMMA-RAY STREAMING THROUGH A STRAIGHT CYLINDRICAL DUCT. Shindo, Mitsuo (Japan Atomic Energy Research Inst., Tokyo); Tsuruo, Akira; Miyasaka, Shun-ichi; Kitazume, Mitsuyuki; Miyakoshi, Jun-ichi. Nucl. Sci. Eng., 27: 450-63(Feb. 1967).

The transmission of gamma rays through a straight cylindrical duct from an infinite plane source has been studied both theoretically and experimentally. The distribution of the resulting dose in the vicinity of the duct was calculated by the ray-analysis method, with the exception that the dose arising from radiation scattered within the duct was calculated by a semi-analytical Monte Carlo method. These results, together with those from experiments, lead to useful conclusions. Data applicable to the design of small ducts through shields have been developed for a range of various geometric parameters. (auth)

21029 WEIGHT OPTIMIZATION OF GAMMA-RAY SHIELDS USING LAYERED MEDIA AND SPHERICAL GEOMETRY. Rohach, Alfred F. (Iowa State Univ., Ames). Nucl. Sci. Eng., 27: 464-7 (Feb. 1967).

It is shown that a combination of light and heavy materials may be used to give an overall optimum spherical shield. Weight optimum effects for gamma-ray shields are determined. Data are presented for various combinations of uranium with iron, lead, and water, for their possible use in shielding transportation containers. (M.H.R.)

21030 VOPROSY FIZIKI ZASHCHITY REAKTOROV. SBORNIK STATEI. VYPUSK 2. (Problems in Physics of Reactor Shielding. Collection of Articles. Issue 2). Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. 245p.

A collection of 28 articles is included. A separate abstract was prepared for each article. (A.G.W.)

For abstracts of individual papers see: 19957, 21031–21048, 21399–21403, 21474, 21475, 21508, and 21571.

21031 OPTIMIZING THE PHYSICAL CHARACTERISTICS OF RADIATION SHIELDING. Orlov, V. V.; Abagyan, A. A.; Fedorenko, R. R.; Dubinin, A. A.; Suvorov, A. P. pp 5-21 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The problem of selecting the ratio of components in reactor shielding to give minimum weight or overall dimensions for a given reduction in radiation intensity or to achieve a minimum radiation dose for given shielding weight or dimensions is considered. The problem is formulated as a variational problem on the optimum of some quantity when given conditions are imposed on other quantities. The various approaches to solution of the problem given in the literature are briefly reviewed. The physical characteristics of the shielding (neutron and gamma doses, heat release, weight, etc.) are considered within the framework of perturbation theory and the concept of functions of effectiveness of shielding materials is introduced. The classical methods of variational calculus are used for determining optimum conditions for functionals representing the various physical characteristics of the shielding. The method of successive approximations is used for solving the problem of optimizing the distribution of shielding components in the general case. An example is given illustrating application of the proposed method. (ATD)

21032 PENETRATION OF NEUTRONS THROUGH PLANE-PARALLEL MULTILAYER MEDIA. Germogenova, T. A.; Suvorov, A. P.; Utkin, V. A. pp 22-39 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

A finite-difference method is proposed for a numerical solution of a one-dimensional kinetic equation describing the penetration of radiation through a material in terms of complex functions of energy, angles, and spatial coordinates. This method is based on the multigroup system of analysis and gives high accuracy while requiring a comparatively small amount of machine time. In solving the finite-difference system, the coefficients of transmission and reflection are calculated for a sequence of layers increasing in thickness and these coefficients are then used for finding the approximate values of radiation intensity. This method is not as sensitive as iteration methods to an increase in the dimensions of the system or to steep gradients in the coefficients. The method is used for analyzing the passage of radiation through a plane-parallel shield consisting of several layers. The proposed method for solving a multigroup system of equations is used as the basis for compilation of programs for calculating the characteristics of one-dimensional shielding. Graphs are given showing the results of calculations for angular distribution of transmitted and reflected radiation, spatial distribution of neutron flux, the fast-neutron spectrum for radiation from an isotropic source, and the change in angular distribution with distance in a medium consisting of hydrogen nuclei for radiation from a plane isotropic source. (ATD)

21033 USE OF THE MONTE CARLO METHOD IN SHIELDING CALCULATIONS. Ermakov, S. M.; Prokof'eva, Z. A. pp 67-71 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Some procedural problems associated with the compilation of programs for solving problems in nuclear radiation shielding by the Monte Carlo method are considered. There are two classical approaches in using this method for calculating the passage of radiation through matter: (1) modeling the behavior of a neu-

tron or γ quantum in the medium and (2) writing out the solution for the integral equation of radiation transfer in the form of an infinite series with terms that are multiple integrals of increasingly higher order (Neumann series) with subsequent application of the Monte Carlo method for calculating these terms. Two problems are considered: the general structure of a program for shielding calculation and the structure of an elementary unit for general shielding geometry. It is assumed that the reader is familiar with the Monte Carlo method as presented in works by Buslenko, Zolotukhin, Vladimirov and others where it is shown that penetration of radiation through matter may be given in terms of the phase coordinates of the particles along its trajectory. A procedure is described for compiling a program to follow this trajectory. Particular emphasis is given to that part of the program for determining the distances travelled by the particle in moving from a given point in a given direction before exit from the medium. An algorithm in ALGOL-60 language is given in the form of a procedure for determining these distances and correlating the corresponding numbers. The resulting geometric unit may be useful in other computational methods, e.g., for constructing three-dimensional nets for difference methods. (ATD)

21034 ANGULAR ENERGY SPECTRA FOR FAST NEUTRONS BEHIND IRON SHIELDING. Germogenova, T. A.; Suvorov, A. P.; Utkin, V. A. pp 74-87 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Some results are given from calculations of the energy and angular distributions of fast neutrons behind flat iron plates of various thickness. In finding the differential intensity of a stream of neutrons $F(x, \mu, \phi, E)$ of energy E at a depth x in the direction Ω determined by the angles $\Theta = \cos^{-1}\mu$ (with the x-axis) and ϕ (azimuth), the kinetic equation $\mu(\partial F/\partial x) + \Sigma(x,E)F(x,\mu,\varphi,E) = \int d\Omega' \int_E^{E^{max}} dE' \Sigma_s (E' \to E, \Omega'\Omega)F(x,\mu',\varphi',E')$ was used together with boundary conditions describing the angular and energy distribution of a plane-parallel radiation beam incident on the surface $x = 0$ of the plate. A program for calculating one-dimensional shielding was used for computing the intensity of scattered radiation $\Phi(x,\mu,\phi,E)$ in the $2P_7$-th multigroup approximation. The main purpose of the calculations was to determine the angular energy distribution of intensity of scattered radiation as a function of spectral and angular characteristics of plane monochromatic sources for various shielding thicknesses. Basically, the distribution of fast neutrons from two sources was studied: $T(d,n)He^4$ and $D(d,n)He^3$. The first source may be considered nearly monochromatic while it is necessary in the second to consider the effect of energy and angle on the intensity of the emitted neutrons. Errors are analyzed. (ATD)

21035 SPECTRA OF FAST NEUTRONS IN HEAVY HOMOGENEOUS MEDIA. Broder, D. L.; Zhilkin, A. S.; Kutuzov, A. A.; Suvorov, A. P. pp 88-103 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The spectra of fast neutrons in iron and lead are measured directly and the asymptotic spectra are calculated in the P_4-th approximation of the method of spherical harmonics using recent measurements for the excitation functions on individual levels in iron and lead. Approximate account is taken of neutron moderation in elastic scattering, and anisotropy due to direct interaction in inelastic scattering. Experimental measurements of the spatial energy distributions of neutrons were done on iron and lead specimens measuring $710 \times 710 \times 600$ mm. Two reactions were used as neutron sources: $T(d,n)^4He$ (14.9 MeV) and $D(d,n)^3He$ (3.35 MeV). Since the deuterium target had a thickness of 20 mg/cm^2, the resultant neutron spectrum in the latter case is not monochromatic. This fact was taken into consideration in the calculations. The neutron spectrometer was a stilbene crystal combined with an FEU-13 photomultiplier and a 100-channel amplitude analyzer. The theoretical and experimental spectra for iron and lead are compared and show generally satisfactory agreement. (ATD)

21036 FAST NEUTRON SPECTRA IN METAL–WATER SHIELDING. Broder, D. L.; Zhilkin, A. S.; Zolotukhin, V. G.; Tarasko, M. Z.; Kutuzov, A. A. pp 104-16 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The spectra of neutrons were studied in the energy range above 1 MeV from sources with energies of 3.35 and 14.9 MeV in water and in water behind layers of iron and lead. A scintillation spectrometer with a stilbene crystal was used for the measurements. The sensitivity to γ quanta was reduced by time division of irradiation. The reactions used for the neutron sources were $D(d,n)He^3$ and $T(d,n)He^4$ produced by using deuterons to bombard zirconium–tritium and zirconium–deuterium targets with a thickness of 18 mg/cm^2. For the measurements in water, the source was located in a paraffin block placed in direct contact with the water tank. The overall dimensions of the shielding were $710 \times 710 \times 600$ mm. The scintillation spectrometer was combined with an FEU-13 photomultiplier and an AI-100-1 amplitude analyzer. The results show that the neutron spectrum from a monochromatic source in lead and iron differs considerably from that in water. The iron and lead spectrum shows a stronger concentration of low-energy neutrons (<2 MeV). In the energy range from 2 MeV to the initial energy of the 3.35-MeV source and from 4 to 5 MeV to the initial energy of the 14.9-MeV source, the spectrum in water contains more neutrons than that in iron and lead. This form of spectrum explains the excellent shielding properties of iron and lead for fast neutrons as well as their poor characteristics for comparatively low-energy neutrons. These data also explain the excellent shielding properties of metal–water shielding throughout the entire energy spectrum. Spectra for neutrons in the energy region below the initial energy in water behind layers of lead and iron approach the shape of spectra in water at a thickness of greater than 20 cm. For thinner water layers, particularly below 2 to 3 MeV, the spectrum shows high concentrations of neutrons in comparison with the spectrum in water. In this transition region there is also a considerable difference from the spectrum in pure water for the energy range from 2 MeV to the initial energy. (ATD)

21037 TITANIUM REMOVAL CROSS SECTION FOR A LAYER IN HYDROGEN-CONTAINING MEDIUM. Egorov, Yu. A.; Orlov, Yu. V.; Pankrat'ev, Yu. V. pp 120-2 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Removal cross sections for titanium were measured in a water–water reactor of the swimming pool type. Sheets of titanium measuring 70×70 cm were placed near the reactor core with dimensions of $50 \times 43 \times 32$ cm. The removal cross section was determined from the expression $N(r)G(r) = N(r-d)G(r-d)e^{-\Sigma_B^d}$, where $N'(r)$ is the neutron flux at distance r, $N'(r-d)$ is the neutron flux at the distance $(r-d)$ when there is no plate, Σ_B is the macroscopic removal cross section, d is the thickness of the plate, and $G(r)$ is the experimentally determined correction factor for geometric attenuation. The results show a removal cross section of 1.72 ± 0.06 barns. The removal cross sections determined for detectors with various effective energy thresholds from 1.1 to 7 MeV coincide within the limits of experimental error. The minimum distance from the plate used for the removal cross section depends on the effective threshold of the detector. For neutrons with an effective energy of 1.5 MeV in polyethylene, this distance is close to 15 cm. The distance decreases with an increase in the threshold. (ATD)

21038 IRRADIATION INTEGRAL AS A FUNCTION OF THE NEUTRON ENERGY SPECTRUM AND THE OPTIMUM STRUCTURE FOR RADIATION SHIELDING IN A REACTOR VESSEL. Orlov, V. V.; Suvorov, A. P. pp 123-40 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The literature on radiation damage in solids and optimum structure of radiation shielding is briefly reviewed and the radiation effect of neutrons on steel is considered. The study is simplified by restriction to the main component of steel, i.e., iron, disregarding the remaining alloying elements. Models of radiation damage in metals are described and applied to the selection of optimum structure for radiation shielding in nuclear reactor vessels. It is shown that the characteristics of optimum compositions for radiation shielding are considerably dependent on the method used for description of radiation damage in the materials used. The expressions derived in the paper are illustrated by application to iron–water shielding. The results may be used for calculating the irradiation integral of reactor vessels and for selecting optimum radiation shielding. (31 references) (ATD)

21039 ENERGY DISTRIBUTION OF NEUTRON DOSE RATE IN VARIOUS SHIELDING MATERIALS AND COMPOSITIONS. Veselkin, A. P.; Netecha, M. E.; Nikitin, A. V. pp 141-9 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

A method is proposed for calculating dose rate from the entire neutron spectrum based on the use of three familiar ideas from the theory of ionizing radiation penetration through matter: the

removal cross section method, the multigroup method for solution of the kinetic neutron transfer equation in the age–diffusion approximation and the concept of the "dosage accumulation factor" for neutron radiation similar in form to the corresponding concept for γ quanta. The method is applicable only within limitations imposed by the removal cross section method and five-group calculation of neutron distribution in the age–diffusion approximation. It is shown that the introduction of a heavy moderator (e.g. iron, titanium, etc.) into a hydrogen-containing material increases the contribution made by intermediate neutrons to the total dose rate. A comparison of theoretical and experimental data shows a difference of less than 20% between calculated and measured dosage accumulation factors. This shows that the proposed method for calculating biological shielding gives sufficiently accurate data on the total radiation dose with respect to neutrons of all energies. (ATD)

21040 ACCUMULATION OF GAMMA RADIATION FROM A PLANE ISOTROPIC SOURCE WITH AN INITIAL ENERGY OF 1.25 MeV IN LAMINAR MEDIA CONSISTING OF POLYETHYLENE, IRON AND LEAD. Kayurin, Yu. P.; Shalin, V. A. pp 151-5 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Experiments are conducted to explain the behavior of accumulation factors for γ radiation from a plane isotropic source in laminar media. The source used was ^{60}Co in a medium made up of various combinations of polyethylene, iron, and lead. Recommendations are given for calculating the accumulation factors for γ radiation in laminar media based on the behavior of accumulation factors for $E_0 = 1.25$ MeV. A comparison with the results in the literature showed that accumulation factors may be calculated in laminar media for higher energies. The experimental results show that the accumulation factor in laminar media made from several materials for the case of both plane and point isotropic sources lies below the highest and above the lowest accumulation factors for the homogeneous materials used in the laminar medium. Empirical formulas for calculating accumulation factors are given, and their uses and limitations are discussed. (ATD)

21041 FUNCTION FOR EFFECTIVENESS OF SHIELDING MATERIALS WITH RESPECT TO CAPTURE GAMMA RADIATION. Abagyan, A. A.; Belov, S. P.; Kazanskii, Yu. A.; Popov, V. I.; Fadeev, I. A.; Dubinin, A. A. pp 164-9 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Experimental and theoretical data on the function for effectiveness of shielding materials with respect to capture γ radiation in nickel are compared. The function of effectiveness is expressed as a linear combination of quantities of the type h_{Ap} $f(x) = h_{Ap} - (\rho_B/\rho_A)h_{Bp}$ where ρ_A and ρ_B represent the concentrations of the respective components in the shielding materials. The function f(x) was experimentally studied by introducing a hydrogen-containing substance into a nickel screen made up of sheets measuring 80 × 80 × 0.8 cm for an overall thickness of 25 cm. This specimen was surrounded by a neutron shield for reducing the background. A single-crystal scintillation gamma spectrometer with a crystal of sodium iodide was used for measuring the number of capture γ quanta with an energy of greater than 7 MeV produced by radiation capture of neutrons in the nickel. Curves are given showing neutron hazard functions with respect to capture γ radiation. These functions describe the contribution of neutrons to the stream of γ quanta behind the screen as a function of the neutron energy and inlet coordinate. The results show that the addition of hydrogen-containing material through nearly the entire thickness of the nickel layer increases the intensity of capture γ radiation behind the screen. An exception to this rule is the first 6 cm of nickel where the neutron hazard function for low-energy particles is less than the function for high-energy neutrons so that a good moderator placed at these points reduces the intensity of capture γ quanta behind the screen. (ATD)

21042 MEASUREMENT AND CALCULATION OF THE COEFFICIENTS OF SECONDARY GAMMA RADIATION. Abagyan, A. A.; Belov, S. P.; Kazanskii, Yu. A.; Mazin, V. I. pp 170-4 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The coefficient of secondary emission β that expresses the ratio of the total number, dose, or energy of capture γ quanta to the total number of neutrons emitted from a given shielding material is considered. The general expression for this coefficient is given. A formula is derived for the asymptotic value of β determined by the physical properties of the shielding material alone. A comparison of theoretical and experimental asymptotic values of β shows a systematic divergence by a factor of approximately 2.5, the theoretical data being overestimated. The reason for the divergence is assumed to be inaccurate determination of neutron intensities at the boundary. In spite of the discrepancy between experimental and theoretical data, the nearly constant divergence obtained for various elements with large, small, and moderate capture cross sections (tungsten, lead, iron, and nickel) indicates that the proposed method may be used for calculating the asymptotic values of β with an accuracy of 30% if a correction factor of 2.6 is used. (ATD)

21043 RADIATION HEATING OF THE SCREEN FOR THE THERMAL SHIELD IN THE TES-3 REACTOR VESSEL. Voznesenskii, R. M.; Gushchina, N. A.; Pokrovskii, Yu. N.; Sergeev, Yu. A. pp 175-83 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Experimental data on radiation heating of the thermal shield in the pressure vessel of the water–water reactor used in the 1500-kW TES-3 atomic electric power station are discussed. Chromel–alumel thermocouples were used for measuring the temperature of the screen in the thermal shield. The thermocouple emf was potentiometrically registered. Curves are given showing heat release in the screen as a function of thickness. A maximum density of total heat release of 9.9 W/cm^3 is observed on the inner surface of the screen. Formulas are derived for determining the temperature distribution in the screen and curves are given showing the temperature difference in the screen and on its inner surface for various reactor power levels. A comparison of theoretical and experimental results shows satisfactory agreement in spite of several sources of error. (ATD)

21044 INVESTIGATION OF THE SHIELDING PROPERTIES OF CONCRETE WHICH CONTAINS BORON. Broder, D. L.; Dergachev, N. P.; Kondrashov, A. P.; Zhiritskii, V. K.; Kozlov, V. N.; Lavdanskii, P. A. pp 184-90 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The shielding properties of concrete containing various concentrations of boron and various quantities of hydrogen were studied. A beam of fast neutrons issuing from a horizontal channel in the shielding of the BR-5 reactor was used in these experiments. The diameter of the beam was 40 mm with a neutron density of 10^9 n/cm^2/sec. The particle detector was a fission chamber with ^{232}Th and indicators made of red phosphorus. The effective threshold of this chamber is close to 1.5 MeV. Indium indicators were used for attenuated streams of thermal and intermediate neutrons. The concrete specimens were made up of 13 plates on a special stand with overall dimensions of 1000 × 1000 × 1300 mm. The first plate in this assembly was made with a recess to fit flush against the reactor shielding and reduce neutron leakage. The detectors were placed in each plate in special vertical channels measuring 50 mm in diameter with a depth of 600 mm. Seven types of concrete were tested with various concentrations of boron and water. The chemical compositions and boron–water concentrations of the various types are tabulated together with their densities. The neutron flux was measured at various heights in the experimental channels. The resultant data are used for calculating the relaxation length for fast, thermal, and intermediate neutrons in 70 to 85 cm of concrete. The experimental relaxation lengths for fast neutrons agree satisfactorily with the theoretical data calculated on the basis of the removal cross section method. The shielding properties of concrete with respect to fast neutrons improve as the water concentration in the concrete is increased from 8 to 24 wt %. An increase in the boron concentration of the concrete results in a considerable reduction in the intensities of thermal and intermediate neutrons and consequently in the production of capture γ radiation. The boron concentration should not be increased past 3 to 4 wt % since this results in a noticeable reduction in the shielding properties of the concrete. (ATD)

21045 STREAMING OF RADIATION THROUGH HOLES FROM SURFACE EMITTERS WITH ARBITRARY ANGULAR DISTRIBUTION. Mironov, V. N. pp 191-7 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

A theoretical method is proposed for studying the passage of radiation through holes with arbitrary angular distribution of the

emitters on the bottom. This method does not require separate integration for each type of surface emitter. It is assumed that a body of volume V is bounded by an arbitrary surface L on which are located surface radiators emitting $E(\theta) = n_0(\theta) \cos \theta$ particles from a unit of area within the unit solid angle in the direction θ. The quantity $n_0(\theta)$ is the flux within the unit solid angle in the direction θ on the surface L. The angle θ is included between the normal to the elementary area of surface L and the path of the particle emitted from the body V. The index "0" indicates that $n_0(\theta)$ is determined on the surface of the source. This flux is normalized so that $J_0 = \int_{-\pi/2}^{\pi/2} n_0(\theta) 2\pi \sin \theta \cos \theta d\theta$ is the total number of particles intersecting a unit of the surface L (the stream on the surface L). The flux is found at the point 0 as well as the current through an arbitrary section ds passing through the point 0 due to radiation of the body V. Radiation from a body of arbitrary shape with homogeneous isotropic sources is considered and expressions are derived for the variation in flux and stream with distance from the emitter for bodies with cosine-law radiation and for circular and rectangular holes. (ATD)

21046 EXPERIMENTS WITH PLANE SLITS OF VARIOUS CONFIGURATION IN RADIATION SHIELDING. Egorov, Yu. A.; Panov, E. A. pp 198-201 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Comparative experimental data are given for the passage of radiation through plane slits of various shapes in the shielding of reactors and radiation sources. The results are compared with respect to the measured distribution of dose rate behind shielding with an air slit and a slit filled with aluminum. An isotropic ^{60}Co source in the form of a plate measuring 250 × 250 mm was used in the experiment and the resultant γ radiation was recorded by a scintillation gamma dosimeter located 40 mm from the shielding. The shielding studied was made up of lead units 90 mm thick with lateral dimensions of approximately 200 and 450 mm. Additional shielding around the source and the pickup was used to eliminate the effect of γ radiation scattered from surrounding objects. Flat and staggered slits were studied as well as a combination of the two configurations. The experimental results show that the integral increase in dose rate for the combination slit is equal within 20% to the sum of the relative dose rate (the ratio of the dose rate behind shielding with a slit to that behind the solid shield) for the plane and staggered slits. It is also shown that combinations of two staggered and one plane slit or two staggered slits give an increase in dose rate equal to the sum of the simple configurations. (ATD)

21047 SPECTRA OF AIR-SCATTERED NEUTRONS FROM A Po-Be ALPHA SOURCE SURROUNDED BY IRON SHIELDING OF VARIOUS THICKNESS. Degtyarev, S. F.; Kukhtevich, V. I.; Matusevich, E. S.; Popov, V. I. pp 202-5 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The energy distributions of neutrons scattered in the unbounded atmosphere were measured. The distance between source and detector was set at 10 m. A composite Po-Be source with an intensity of approximately 5×10^8 n/sec was used with surrounding iron shielding having wall thicknesses of 5, 10, and 15 cm. A spherical ionization chamber filled with a mixture of 5 atm of argon and 5 atm of hydrogen was used for neutron detection. The measurements were made in the 0.8 to 3.0 MeV range. The results show unbalanced neutron spectra in iron at low energies (average spectral energy from the Po-Be source is 4.5 MeV). The initial neutron spectrum is softened by scattering in air at the energies studied. The number of scattered neutrons decreases smoothly with respect to the number of unscattered neutrons with an increase in the initial energy from 0.28 at $E_n = 0.8$ MeV to 0.15 at $E_n = 3$ MeV. The data may be used for modeling various descending continuous spectra and for estimating and calculating the background due to neutrons scattered in air. (ATD)

21048 ENERGY DISTRIBUTION AND DOSE RATE OF GAMMA QUANTA SCATTERED AT THE AIR-EARTH INTERFACE. Kolevatov, Yu. I.; Kukhtevich, V. I.; Trykov, O. A. pp 216-25 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The angular energy distribution of scattered γ radiation from an isotropic point source (^{60}Co) at source-to-detector distances of 50 and 30 m and heights above ground level of 2 to 53 m were studied. A method is proposed for determining the scattering field of γ radiation close to the boundary between two media based on an analysis of the results of this work and a comparison with the data in the literature. About 70 energy distributions were measured in all covering a range of 12 to 180° for θ and 0 to 140° for ϕ. The results show that the parameters h, R, θ, and ϕ have a characteristic effect on the form of the angular energy distributions. Sharp maxima are observed in the energy region above 0.22 MeV due to single scattering of γ quanta from the surface of the earth at an angle ψ. In the limiting case at an infinite distance from the surface of the earth the angular energy distributions have a maximum in the region of approximately 0.22 MeV due to single scattering of γ quanta through an angle π. The spatial energy distributions of scattered γ quanta from an isotropic point source also show a maximum in the region of approximately 0.22 MeV, which disappears with a reduction in the ratio h/R. A comparison of the theoretical and experimental data for the spatial distribution of the dose rate of scattered γ radiation from an isotropic source close to the earth-air interface as a function of h and R shows agreement with an average accuracy of ±20%. (ATD)

Solid-State Physics

Refer also to abstracts 19945, 19999, 20511-20516, 20518, 20542, 20569, 20571-20573, 20736, and 21532.

21049 (CEA-R-3096) CALCUL DES FORCES AGISSANT SUR UNE IMPURETE D'UN METAL SOUMIS A UN GRADIENT DE TEMPERATURE. (Calculation of Forces Acting on an Impurity in a Metal Subjected to a Temperature Gradient). Gerl, Maurice (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1966. 37p. (In French). Dep. mn.

In a metal subjected to a temperature gradient, an impurity is submitted to both an electrostatic force due to the thermoelectric field and a force due to the scattering of electrons and phonons by this point defect. The scattering of the electrons is treated using a semiclassical approach and a quantum mechanical method. The numerical computation for several impurities in Cu, Ag, and Au requires the knowledge of the resistivity cross section and of the thermoelectric power of the impurity in the metal. A tentative estimation of the force due to the phonon scattering is given for the self-diffusion in Cu. However, the approximations of this calculation do not allow a good comparison with the force due to the electrons. (tr-auth)

21050 (IAE-1221) ISSLEDOVANIE EFFEKTA MESSBAUERA NA PRIMESNYKH YADRAKH ^{161}Dy V GADOLINII. (The Study of the Moessbauer Spectra of an Admixture of ^{161}Dy Nuclei in Gadolinium). Sklyarevskii, V. V.; Lukashevich, I. I.; Aleshin, K. P.; Filippov, N. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 11p. (In Russian). Dep. mn.

The Moessbauer spectra of 25-keV gamma rays ($5/2^+ \rightarrow 5/2$ transition) emitted by an admixture ^{161}Dy nuclei in polycrystalline gadolinium have been investigated. The results showed: the influence of irradiation intensity of the ^{161}Dy : Gd source within the reactor on the relative intensity of the two systems of magnetic superfine splittings appearing in ^{161}Dy spectra (with very high exposures a very sudden change in the temperature dependence of the ^{161}Dy nuclear field is observed, which is apparently caused by the radiation damage of Gd); a line shift in the T > 180°K region yielding different values for the nuclear field as determined for different lines of the spectrum; a strong influence of the external applied magnetic field on the magnitude of the ^{161}Dy nuclear field and the line shift; and peculiarities in the temperature dependence of the Moessbauer effect probability at the Curie point of gadolinium. The sharp change in probability in the presence of an external field is apparently connected with the magnetostriction of gadolinium. (JPRS)

21051 (IS-T-149) THERMAL CONDUCTIVITY OF MAGNESIUM STANNIDE. Martin, Joel Jerome (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 84p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The thermal conductivity of several n-type Mg_2Sn samples was measured from 4.2 to 300°K. The samples had uncompensated donor concentrations on the order of 2×10^{18} donors/cm^3. Above 150°K, the thermal conductivity showed a T^{-1} temperature dependence, which is characteristic of lattice thermal conductivity. The theory for high-temperature thermal conductivity of Leibfried and Schloemann is in agreement with the results. The bipolar electronic contribution was estimated to be 4% of the total thermal conductivity at 300°K. Below 100°K, the data were analyzed in terms of the Callaway theory by combining the relaxation times for phonon-phonon scattering, isotope scattering, boundary scattering, and bound donor electron-phonon scattering. Above the thermal conductivity maximum it was necessary to retain the $\exp(-\theta/aT)$ term in the phonon-phonon scattering process to ob-

tain the correct temperature dependence. The calculation in the neighborhood of the thermal conductivity maximum indicated that the only point defect scattering present in the samples was caused by the isotopes of Mg and Sn. At 4°K the data showed a smaller size dependence than the theory predicted if only boundary scattering was included. In addition, the measured values were about half of the curves calculated with only boundary scattering. This result was explained in terms of an additional phonon scattering caused by the bound donor electrons. With this mechanism it was possible to account for the size difference and the difference in doping in the samples. As an auxiliary experiment the Seebeck coefficient was measured at the same time as the thermal conductivity. The phonon drag contribution to the Seebeck coefficient shows a $T^{-2.5}$ temperature dependence from 30 to 100°K. (auth)

21052 (N-67-13103) SOLID STATE RESEARCH OF THE APPLIED PHYSICS DEPARTMENT FOR THE YEAR 1965. Scanlon, Wayne W. (Naval Ordnance Lab., White Oak, Md.). June 29, 1966. 58p. (NASA-CR-80478; NOL-TR-66-139). CFSTI $3.00 cy, $0.65 mn.

Basic research efforts in the fields of magnetism and semiconductors, and applied research in infrared and metallurgy are reviewed. Semiconductor research continues to be concentrated on small-band-gap materials for use as infrared detectors, sources, or filters. This work was extended to still smaller-energy-gap materials (e.g., tin telluride) that border on metallic behavior. A technique for making thin single-crystal films by epitaxial vacuum evaporation was developed, which is particularly useful in studying alloy compositions used in semiconductors. Research in metallurgy included studies of the crystal structure of the family of alloys TiFe, TiCo, and TiNi. A unique martensitic transition was found in all these metals. The magnetic behavior of the alloys was studied, and anisotropy in rare earth metals is being studied in magnetic fields up to 140 kOe. The antiferromagnetic structures of MnP, $EuTiO_3$, and $RbMnCl_3$ were established by neutron-diffraction studies. Other research efforts discussed include: the optical transmission of water in the highest transmission vicinity, the green wavelength; electron irradiation treatments of low coercive force Ni-Fe alloys; and shock waves in water from high intensity laser radiation impingement on the water. Other research efforts are also discussed. (STAR)

21053 (NYO-2391-18) EXCITON IMPURITY STATES IN MOLECULAR CRYSTALS. Takeno, Shozo (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Sept. 1965. Contract AT(30-1)-2391. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effect of impurities on Frenkel excitons in molecular crystals is studied with particular attention to impurity levels appearing outside exciton bands and virtual impurity levels lying in the continuum. A study is made of a specific case in which the transition dipole moments of the impurities are parallel to those of the host molecules. A secular equation that determines the energies of impurity levels due to any number of impurities is obtained, and a resonance form of the inverse relaxation time of excitons scattered by an impurity is derived. In the one-impurity problem a detailed discussion is made of the criterion for the appearance of impurity levels. It is concluded that for excitons with fairly large effective masses these impurity states are very likely to occur. Numerical calculations are performed for a simple cubic lattice in which only interactions between nearest-neighbor molecules are important. The results are then applied to a study of the interaction of impurity levels due to small but finite concentrations of impurities. It is shown that there can exist long-range jumps of excitons from one impurity site to another because of the dipole-dipole interaction. An impurity-induced energy transfer is suggested. (auth)

21054 (NYO-2391-19) CHARACTERISTIC TEMPERATURE DEPENDENCE FOR LOW LYING LATTICE RESONANT MODES. Takeno, S.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Dec. 1965. Contract AT(30-1)-2391. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Impurity-induced lattice absorption in the far-infrared spectral region was studied. Experimental results are shown for a resonant mode absorption produced by a heavy impurity (KI: Ag^+) and by a light impurity (KBr: Li^+). A marked temperature dependence of the resonant mode absorption strength was observed. Interpretation of the results leads to the conclusions that the observed temperature dependence probably is characteristic of lattices that contain low-frequency resonant modes and that a temperature-dependent contribution to the static dielectric constant should occur. (A.G.W.)

21055 (UCRL-16037(Rev.)) RELAXATION ENERGY OF VACANCIES AND IMPURITIES IN A MOLECULAR LATTICE. Burton, James J.; Jura, George (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1965. Contract W-7405-eng-48. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The energy of relaxation and relaxation of surrounding atoms are computed for vacancies, large and small impurity atoms, vacancy-impurity atom di-defects, and di-vacancies in a fcc (argon) lattice, assuming a Lennard-Jones potential and neglecting all kinetic energy effects. It is found that at normal lattice spacing the energy correction is small for all types of defects considered. Under compression, relaxation energy increases rapidly. Relaxations are always small. It is found that formation of a vacancy next to an impurity is preferred to formation of an isolated vacancy. Concentration of di-vacancies is found to be very small except at temperatures approaching the melting point. (auth)

21056 (UCRL-16264) USEFUL PROPERTIES OF DARK-FIELD ELECTRON IMAGES. Bell, W. L.; Thomas G. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1965. Contract W-7405-eng-48. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Tilting experiments in dark-field under $s \neq 0$ conditions have shown that the image contrast is greatest at the top and bottom surfaces of a foil for $s < 0$ and $s > 0$, respectively. This effect has been shown for images of stacking faults or slip traces, inclined dislocations, prismatic loops, precipitates, and small defects observable by strain contrast. This asymmetry is observed only where anomalous absorption is an important factor in controlling the image intensity. The effect can be utilized for obtaining the unique foil orientation without using complicated procedures, such as wedge tilting or x-ray analysis of the foil in the specimen holder. Once the unique orientation is found, a complete analysis of lattice defects can be carried out with a maximum of two dark-field photographs. The approximate position of a defect within the foil can also be determined. (auth)

21057 (ZFK-WF-29) ZUM EINFLUSS EINIGER FAKTOREN AUF DIE STRAHLENINDUZIERTEN EIGENSCHAFTSAENDERUNGEN IN FESTKOERPERN. (Influence of Some Factors on the Radioinduced Changes in Characteristics of Solids). Balarin, M.; Hauser, O.; Schenk, M.; Zetzsche, A. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). May 1966. 21p. (In German). Dep. mn.

A bibliographic review is given of studies on the radioinduced property changes in solids. The factors modifying the property changes are types of interaction (nuclear transformations, ionization, and elastic collision), structure of the defect (single defects, cascades, and aggregates), and initial state of material (chemical impurities and physical hole formation). Studies showing the influence of each of these factors are reported and summarized. (J.S.R.)

21058 ELECTRON EXCITATIONS AND ELECTRON PROCESSES IN LUMINESCENT IONIC CRYSTALS. Lushchik, Ch. B. Tr. Inst. Fiz. Astron., Akad. Nauk Est. SSR, No. 31, 19-83(1966). (In Russian).

The principal research results of a group of physicists of the Physics and Astronomy Institute (Academy of Sciences of the Estonian SSR) for the period 1955-1965 are summarized. The electron excitations and their role in luminescent phenomena as well as in radiation-induced coloration, electron conductivity, and electron emission are considered. (auth)

21059 MULTIPLICATION OF ELECTRON EXCITATIONS AND GENERATION OF RADIATION DEFECTS IN IONIC CRYSTALS. Il'mas, E. R.; Lushchik, Ch. B.; Rooze, N. S. Tr. Inst. Fiz. Astron., Akad. Nauk Est. SSR, No. 31, 84-100(1966). (In Russian).

The spectra of F-centers creation and the excitation spectra of stationary luminescence were investigated for NaCl(Tl) crystals in the range of exciting quanta from 4 to 21.2 eV. In the 21.2 eV region, the quantum efficiency of F-centers creation, as well as the luminescence quantum efficiency, has a sharp rise with increasing energy of exciting photons. Both effects have the same origin. They are connected with generation of two electron-hole pairs by one photon. Each of the pairs participates in the creation of F centers or in the excitation of Tl^+ centers. On the basis of the kinetics of the creation process of F centers by the 10.2- and 21.2-eV quanta, the conclusion was drawn that both electron-hole pairs, generated by a 21.2-eV quantum, arise in close proximity. Micromechanisms of the multiplication of the electron excitations in ionic crystals are discussed. (auth)

21060 INVESTIGATION OF ELECTRON AND HOLE PROCESSES IN KCl:Ag CRYSTALS BY THE ELECTRON SPIN RESONANCE METHOD. Pung, L. A.; Khaldre, Yu. Yu. Tr. Inst.

Fiz. Astron., Akad. Nauk Est. SSR, No. 31, 133-41(1966). (In Russian).

The variations in the number of hole (Cl_2^-, Ag^{2+}, $BrCl^-$) and electron (Ag^0) color centers in KCl : Ag single crystals x irradiated at 77°K were investigated by the ESR method in their dependence on the temperature of pulse annealing. The intensity of the ESR absorption served as a measure of the number of color centers. The ESR data permit a reliable determination of the "polarity" (electron or hole character) of the observed stages of the relaxation process. (auth)

21061 ELECTRON–HOLE COMPONENT OF THE RADIOLUMINESCENCE OF ALKALI METAL HALIDE SCINTILLATORS. Kink, R. A.; Liid'ya, G. G. Tr. Inst. Fiz. Astron., Akad. Nauk Est. SSR, No. 31, 142-59(1966). (In Russian).

The thermal glow of alkali metal halide crystals activated with thallium and indium (NaI : Tl, NaI : In, KI : Tl, KI : In, RbI : Tl, RbI : In, CsI : Tl, CsI : In, KBr : Tl, KBr : In, RbBr : Tl, NaBr : Tl, KCl : Tl, KCl : In, NaCl : Tl, NaCl : In) was examined. The crystals were excited by x rays or ultraviolet radiation at liquid nitrogen temperatures. The room-temperature lifetime of electrons (holes) at the traps was estimated by the analysis of main low-temperature glow peaks corresponding to these traps. The following conclusions are drawn: (1) Among a great number of thallium- and indium-activated alkali metal halide crystals, only in NaI : Tl, NaI : In, and CsI : Tl are the trapping levels so shallow that their decay time at room temperature is essentially less than the lifetime of the excited state of a luminescence center. However, the main part of the light sum (more than 90%) is stored by these shallow levels. Consequently, the electron–hole component can give an appreciable contribution to the radioscintillations of these phosphors in the presence of intermediate localizations. (2) In other thallium-doped alkali metal halides the activator generates deep and effective electron traps. The main part of the light sum is stored at these traps, but their decay time exceeds the mean lifetime of excited luminescence centers. Thus, the efficiency of the electron–hole component of radioscintillations is low. (3) In the indium-activated phosphors (except for NaI) the activator also creates effective traps. However, determination of their decay times was impossible with the methods used. (4) In the KCl phosphors the recombination luminescence decay time is of the order of milliseconds, without participation of activator trapping levels. This is a result of the strong bond of holes in the self-trapped state. (auth)

21062 PHOTO- AND RADIOLUMINESCENCE OF ZnS:Ag PHOSPHOR UNDER CONDITIONS OF EXTERNAL QUENCHING. Gorbachev, B. N. Tr. Inst. Fiz. Astron., Akad. Nauk Est. SSR, No. 31, 229-45(1966). (In Russian).

The influence of several factors such as temperature variations, nickel impurities, pulse or steady excitation conditions upon the photo- and radioluminescence of ZnS : Ag was investigated. The conclusion is drawn that in ZnS : Ag during photoexcitation in the fundamental absorption band and during excitation of radioluminescence the electron–hole mechanism of energy transfer to the luminescence centers is realized. The dependence of ZnS : Ag luminescence yield on the volume density of photoexcitation is nonlinear. This is the circumstance determining the α/β ratio (ratio of luminescence efficiencies under excitation by α and β particles) in this phosphor. The possibility of modelling radioluminescence by means of photoluminescence processes is analyzed. (auth)

21063 RISE AND DECAY OF SCINTILLATIONS IN THALLIUM-ACTIVATED ALKALI METAL IODIDES. Realo, E. Kh.; Soovik, T. A. Tr. Inst. Fiz. Astron., Akad. Nauk Est. SSR, No. 31, 275-7(1966). (In Russian).

The rise and decay of α and γ scintillations in NaI : Tl, KI : Tl, RbI : Tl, and CsI : Tl containing 0.1 mole % thallium were studied in order to determine the mechanism of scintillations. Scintillations were induced by ^{239}Pu α particles and ^{60}Co γ quanta. Results confirmed that at room temperature the decay time of the basic scintillation component is determined by the lifetime of the $^3P_{0,1}$ Tl center. KI : Tl and RbI : Tl have the most rapid rise time ($\approx$ 10 sec), and the slowest was observed in Cs(Tl). (R.V.J.)

21064 ROENTGENOLUMINESCENCE OF AND TRAPPING LEVELS IN NaCl AND KCl CRYSTALS ACTIVATED BY Ag AND Cu. Parfianovich, I. A.; Shuraleva, E. I.; Penzina, E. E.; Krongauz, V. G. (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 581-9(Apr. 1966). (In Russian).

The mechanism of roentgenoluminescence (RL) in Ag-activated NaCl and KCl crystals was investigated, and comparative data on RL of like crystals activated by Cu were obtained. The work included determination of the temperature dependence of the stationary RL and recording thermostimulated and light-stimulated emission curves. The experimental data are presented mainly in the form of graphs: plots of buildup of RL, temperature dependences of the RL and glow curves, Ausleuchtung curves, optical flash curves, and absorption curves. At temperatures above 100°C the RL spectra of all the phosphors have a principal peak associated with type-I centers. NaCl : Ag and NaCl : Cu also exhibit an emission identified with type-II centers. The KCl phosphors, in addition to the type-I-center luminescence, emit visible bands that cannot be identified with type-II centers. In general, the stationary RL is made up of two components—a short-lived one and a long-lived one—which are characterized by different relative intensities at different temperatures. The experimental data are analyzed at some length and some hypotheses are proposed. It is noted that the characteristic green phosphorescence of KCl : Ag is also observed, although in weaker form, in the case of pure KCl crystals. In view of the temperature range in which this green afterglow is evinced it is inferred that this emission is due to recombination of free electrons with V_k centers, for holes are immobilized at low temperatures. However, holes may participate in other forms of green luminescence. In general, there apparently participate in the roentgenoluminescence of alkali metal halide phosphors several different types of centers (including oxygen centers), some of which are more active in one temperature range and some in another; both electron and hole processes are significant above the temperature of self-trapping of holes. (ATD)

21065 SOME PECULIARITIES OF THE ROENTGENOLUMINESCENCE OF NaCl AND KCl CRYSTALS ACTIVATED BY Ag AND Cu. Parfianovich, I. A.; Babin, P. A.; Shuraleva, E. I. (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 590-2(Apr. 1966). (In Russian).

Investigations have shown that NaCl and KCl phosphors doped with Ag and Cu exhibit some peculiarities as regards buildup of their roentgenoluminescence (RL) and the temperature dependence of the RL. In the series of experiments first described the phosphor specimens were first x irradiated to attainment of a steady RL intensity; then the radiation was cut off for a period (dark pause), and then again turned on. The results are presented in the form of growth curves; it was found that, whereas in the case of both NaCl : Ag and NaCl : Cu the second growth curve is virtually identical with the initial one, in the case of KCl phosphors the dark pause results in initial intensification of the RL, that is, instead of the gradual rise characteristic of the initial irradiation (and of the NaCl phosphors) the emission abruptly rises to a sharp peak that is substantially above the steady RL level and then gradually falls off to the steady level (in some cases with a slight preliminary dip). This effect is temperature dependent and disappears about 308°K. This would imply that the "flash" effect is due to some sort of trapping centers that dissociate at this temperature; the possible nature of these centers is discussed in general terms. Further experiments involved study of the temperature dependence of the RL and recording of glow curves after x-ray excitation. Here again the curves for the NaCl and KCl phosphors are different; KCl : Cu, for example, is characterized by strong increase in the RL intensity in the temperature region of quenching of the photoluminescence excited in the range of the long-wavelength absorption band. Some possible reasons for this phenomenon are suggested. It is inferred that in the range of higher temperatures, where trapping of current carriers is unlikely and RL is the only detectable form of recombination luminescence, there occurs a change in the mechanism of excitation energy transfer to the luminescence centers. (ATD)

21066 INVESTIGATION OF SCINTILLATION PROCESSES IN ZnS:Ag SINGLE CRYSTALS. Bezel, V. S.; Gavrilov, F. F.; Panov, V. P.; Krainyukov, N. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 668-70(Apr. 1966). (In Russian).

Although in general the regularities evinced in radioluminescence of ZnS : Ag single crystals can be explained in the framework of the same energy-band diagram as that invoked for interpreting the photo- and cathodoluminescences of this phosphor, the much higher excitation density in the case of radioluminescence gives rise to some distinctive effects. The present work, accordingly, was devoted to experimental investigation of the influence of the excitation density along the particle track on the thermostimulated emission (glow curves), decay time, emission spectrum, and electroquenching. The specimens were relatively large ZnS : Ag (about 3×10^{-5} g/g Ag) single crystals grown from a melt. The excitation was produced by ^{239}Pu and ThC–ThC' alpha particles, protons, deuterons, gamma rays, and Hg ultraviolet. The glow curves were recorded after excitation with 2- and 5-MeV alphas and with uv. All three glow curves have peaks at –150°, but only the glow curve obtained after uv excitation exhibits a broad peak located just below 0°C. The trap depth corresponding to the –150°C peak is estimated as 0.25 to 0.28 eV. The persistence of the scintillation

falls off with increasing excitation density along the track in agreement with the theoretical curve. The intensity in the short-wavelength part of the radioluminescence spectrum increases with increasing excitation density for all forms of excitation. Electroquenching (quenching by a dc field) was found to be analogous to temperature quenching. (ATD)

21067 EFFECTS OF X IRRADIATION AND HEAT TREATMENT IN DIFFERENT ATMOSPHERES ON THE OPTICAL AND LUMINESCENCE PROPERTIES OF CADMIUM TUNGSTATE. Limarenko, L. N.; Nosenko, A. E.; Pashkovskii, M. V.; Furtak, S. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 671-4(Apr. 1966). (In Russian).

In an attempt to develop new laser materials, $ZnWO_4$ and $CdWO_4$ single crystals were grown from melts by the Czochralski technique; reagent grade and spectroscopically pure raw materials were employed. The activator was Tb with one-tenth as much lithium added to facilitate incorporation of the Tb into the tungstate lattice. In some cases CaO was employed to loosen the lattice. The best results were obtained with the $CdWO_4$. The luminescence measurements were performed on plates cleaved from the single crystals parallel to the (010) planes. Ultraviolet-stimulated luminescence curves are presented for pure and Tb-doped (1% Tb + 3% CaO) $CdWO_4$ specimens; the doped specimens at liquid-nitrogen temperature have a high double peak at about 540 mμ, whereas the pure compound has a broad peak centered at about 500 mμ. The x-ray-stimulated spectra were also investigated; these indicate that different excitation mechanisms are involved. This is substantiated by the glow curves recorded for doped crystals after uv and after x-ray excitation. $CdWO_4:Tb^{3+}$ crystals grown in air were slightly smoky. X irradiation of clear crystals at room temperature resulted in light coloring but no significant change of the photoluminescence. Annealing in oxygen led to bleaching, also with no significant change in luminescence properties. Annealing in vacuum (1 hour at 700°C) resulted in noticeable darkening of the crystals and reduction of the luminescence intensity by a factor of about three. The probable reasons for this are suggested. The changes in the glow curves as a result of doping with Tb and Ca are briefly described. (ATD)

21068 ON THE APPEARANCE OF AN EMF INCIDENT TO ANNEALING OF THE β-IRRADIATED ALKALI METAL HALIDE CRYSTALS. Shibaev, V. A.; Avdonin, V. P.; Vasil'ev, I. A.; Mikhal'chenko, G. A.; Plachenov, B. T. (Leningrad Technological Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 679-80(Apr. 1966). (In Russian).

In the course of study of the conductivity of alkali metal halide crystals it was discovered that if a crystal is irradiated with beta particles at 90°K, upon subsequent heating of the crystal, in addition to the familiar thermostimulated luminescence, there is observed a free charge on the surface of the crystal that faced the beta source. This emf is tentatively termed the thermostimulated concentration emf. This charge was collected on a sputtered aluminum electrode connected to an appropriate indicator. The present experiments involved measurements with a sputtered electrode and with a noncontacting electrode, mounted 0.2 to 0.5 mm from the crystal surface (in the latter case the effect is weaker and opposite in sign). The purpose of the measurements was to determine the magnitude of the charge; this was done by applying a dc voltage sufficient to realize compensation. The measurement results are presented in the form of curves. Two mechanisms of the effect are hypothesized: one is essentially the electric mechanism; the other is based on nonuniform distribution over the thickness of carriers held in traps. An argument in favor of the latter mechanism is the near identity of the temperature of the glow-curve and charge peaks. (ATD)

21069 IS PROTON CHANNELING A DIFFRACTION PROCESS? Fowler, H. A. (National Bureau of Standards, Washington, D. C.); Erginsoy, C. Contract AT(30-2)-Gen-16. Phys. Lett., 24A: 390-1(Mar. 27, 1967). (BNL-11075).

Diffraction and inelastic (plasmon excitation) parameters are compared for 80-keV to 1-MeV electrons and 1 to 5 MeV protons in silicon. It is concluded that proton diffraction will be choked off by inelastic interactions, since an elastically scattered wave cannot propagate from one Bragg-reflecting plane to the next. (auth)

21070 CHARACTERIZATION OF CRYSTAL DEFECTS BY THE FOURIER TRANSFORM OF LONG WAVELENGTH NEUTRON SCATTERING DATA. Mitchell, E. W. J.; Stewart, R. J. (Univ. of Reading, Eng.). Phil. Mag., 15: 617-22(Mar. 1967).

Long-wavelength neutron scattering by defects in crystalline solids allows information to be obtained about the structure of complex defects. It is shown that it is possible in principle to transform the wavelength dependence of the total (transmission) cross section to the pair distribution function of "defect matter." (auth)

21071 EFFECT OF THE EXCITATION DENSITY ON THE RADIOLUMINESCENCE OF ZnS:Ag SINGLE CRYSTALS. II. Bezel', V. S.; Gavrilov, F. F. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 56-62(1966). (In Russian).

The role of electron trapping in processes of radioluminescence is analyzed on the basis of an investigation of the dependence of scintillation-damping duration on temperature in thermoluminescence curves, and the relationship between the amplitude and damping duration in ZnS:Ag. The causes of the nonequilibrium filling of electron trappings during excitation by α particles are discussed. Wide use is made of the relationships obtained by other researchers in photoluminescence and cathodoluminescence studies. (ATD)

21072 EFFECT OF EXCITATION DENSITY ON THE RADIOLUMINESCENCE OF ZnS:Ag MONOCRYSTALS. I. Bezel', V. S.; Gavrilov, F. F. (Ural Polytechnical Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 138-41(1966). (In Russian).

The effect of excitation density on the temperature quenching of α-particle-induced radioluminescence of ZnS:Ag monocrystals is investigated. The radius of the excitation channel as dependent on the energy of the alpha particles is evaluated. Corrections are introduced into the dependence of the scintillation amplitude on the excitation density, which deviates from the law by the factor ½. (JPRS)

21073 CHARACTERISTICS OF THE ELECTRIC CONDUCTIVITY OF ALKALI SILICATE GLASS IN STRONG ELECTRIC FIELDS AFTER EXPOSURE TO GAMMA RADIATION. Siryak, A. I. (Siberian Physical Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 31-5(1966). (In Russian).

An explanation is given of the stable radiation-induced variations in electric conductivity in strong electric fields in sodium silicate glass. The concept of the accumulation of volume charge, which produces high-voltage polarization in the presence of electrons induced by gamma radiation, is applied. It is assumed that the recombination of electrons and sodium cations and their dissociation are controlled by a strong electric field. (ATD)

21074 EFFECT OF GAMMA RADIATION ON THE DIELECTRIC CHARACTERISTICS OF QUARTZ. Potakhova, G. I. (Siberian Physical Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 110-13(1966). (In Russian).

An experimental investigation was made of the effects of gamma radiation on the dielectric losses and polarization in single-crystal and fused specimens of quartz. Conductivity was measured simultaneously with the dielectric loss angle to establish the role of the former in the mechanism of dielectric losses. The measurements were conducted in the 40 to 10^4 cps frequency range at room temperature and at pressure below 10^{-3} mm Hg to avoid the distorting effects of ionized air. Various intensities of gamma radiation were supplied from a ^{60}Co source. In single-crystal specimens, gamma radiation caused a considerable increase with time in the loss angle, which was accompanied by a decrease of permittivity. The change in capacitance was less than the change in the loss angle, changes in the latter being more pronounced at lower frequencies of the electric field. Following irradiation, both the capacitance and the loss angle decreased. Seventeen hours after irradiation, the loss angle had not yet returned to its original value. The sustained value of the loss-angle tangent was proportional to the square root of the radiation intensity, with a coefficient depending on the properties of the crystal specimen. This coefficient was considerably less for single crystals of natural quartz, which, in addition, did not display any change in permittivity. The effects of gamma radiation on quartz characteristics were in general analogous to those observed under x radiation except for the increased capacitance, which does not occur in the case of x rays. For identical specimens, the loss angle changes were higher in the case of gamma radiation than for x radiation. Simultaneous conductivity measurements showed the effect to be greater in single crystals than in fused specimens, but not to the extent of explaining the increase in the loss angle in single crystals. The character of the relaxation curves of the capacitance and loss angle confirmed the existence of a polarization process. In fused specimens, only the steady-current value was affected by radiation. Generally, gamma radiation brought about changes in the loss angle, the permittivity, and the establishment of the steady-state current in quartz single crystals, which phenomena can be explained by the polarization of trapped electrons. In fused quartz, none of these effects was observed. (ATD)

21075 EFFECT OF X-RAY AND ELECTRON IRRADIATION ON GALLIUM ARSENIDE P–N JUNCTIONS. Krivov, M. A.; Malyanov, S. V. (Siberian Physical-Technical Inst., Tomsk,

USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 6, 135-6(1966). (In Russian).

A study was made of the effect of x-ray and electron irradiation on the volt–ampere characteristics of gallium arsenide p–n junctions with an initial concentration of current carriers of ~4 × 10^{18} cm^{-3} and mobility of 3500 cm^2/V sec. The irradiation of the p–n junctions was accomplished using x rays and electrons with energies of 90 keV and 6.5 MeV respectively. The results indicated that direct and reverse currents in p–n junctions are increased owing to the appearance of nonequilibrium current carriers during x irradiation. Because of imperfections in gallium arsenide crystals, the speed of the recombination of current carriers was sufficiently high, and the observed changes of characteristics during irradiation were much smaller than changes during the irradiation of germanium and silicon diodes. The coefficient of rectification of p–n junctions during irradiation varies by as much as 40% from the initial value. The reverse current of a p–n junction irradiated by electrons increases sharply in the prebreakdown voltage regions, and the breakdown voltage is decreased. This reverse branch of the characteristic can be explained by the development of radiation defects in the p–n region of the junction. It is concluded that the gallium arsenide p–n junctions are stable during irradiation by x rays and fast electrons. The coefficient of rectification of irradiated electrons of the p–n junction decreases as the radiation dose increases. It decreases by 10% when the integral electron flux is ~1.5×10^{16} cm^{-2}. (ATD)

21076 KINETICS OF STORED-ENERGY BUILDUP IN ALKALI METAL HALIDE CRYSTALS AFTER IRRADIATION BY PROTONS. Zavadovskaya, E. K.; Kuz'mina, A. V.; Golovchanskii, E. M.; Vakhromeev, V. G. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 163-5(1966). (In Russian).

The kinetics of stored-energy buildup in NaCl, KCl, KBr, and KI crystals after irradiation at room temperature by 4.5-MeV protons were studied. The magnitude of the stored energy during proton irradiation of these crystals is found to increase in proportion to the lattice energy of the crystal. In the case of all the crystals the stored-energy buildup with increasing irradiation dose is found to occur in two stages: the first, a fast stage, is related to the presence of F centers, while the second, a slow stage, is related to the presence of complex electronic defects. (Int. Aerospace Abstr.)

21077 EFFECT OF X RADIATION ON GERMANIUM AND GERMANIUM P–N JUNCTIONS. II. ELECTROPHYSICAL PROPERTIES OF GERMANIUM IRRADIATED BY HARD X-RAYS. Krivov, M. A.; Malyanov, S. V. (Siberian Physical-Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 84-7(1966). (In Russian).

An experimental investigation was made of the effect of hard x radiation on the properties of low- and high-resistance n- and p-type germanium. An RUP-200 industrial x-ray installation was used as the radiation source. The dependence of conductivity, concentration, and mobility of current carriers on the absorbed dose of radiation was measured at source energies ranging from 90 to 180 kV and 1.5 to 4 mA. The absorption coefficient of the x ray was calculated. The most interesting results were obtained at the maximum x-ray tube voltage (λ = 0.138 Å), since the absorption under these circumstances remained low (8.5 cm^{-1}), extending the effects into the depth of the material and changing sharply the photoelectrically activated surplus carriers that lead to the occurrence of low-level excitation ($\Delta n(\Delta p) \ll n_0 + p_0$). The measurement data revealed that the dependence curves of conductivity, concentration, and mobility of current carriers on the dose of absorbed radiation are analogous to those observed under soft x radiation for both low- and high-resistance n- and p-type specimens. An analysis of cases of low-level excitation, described by equations $\Delta n = \Delta n_{st}(1 - e^{-ct})$ for irradiation and $\Delta n = \Delta n_{st} e^{-ct}$ for relaxation (Δn is the photoelectric increment of surplus carrier concentration from x rays, Δn_{st} is the stationary value of the same increment, and t is the irradiation time or relaxation time) is presented, under the assumption that the parameter $c = 1/\tau_{rel}$ (τ_{rel} is the relaxation lifetime of carriers under impact recombination). The values of both $\lg(1 - n/\Delta n_{st})$ and $\lg(\Delta n/\Delta n_{st})$, plotted versus time in semilogarithmic coordinates, show that experimental points lie on a straight line with a slope tangent equal to the parameter c. In the case of irradiation, the curve deviates upward after about 220 minutes when the surplus carrier concentration reaches its stationary value, after which the curve follows a different law, the investigation of which is considered very difficult at the present time. The tabulated values of c and τ_{rel} were shown to be of the same order for all specimens. A certain scattering in coefficient values can be attributed to structural imperfections or the presence of unidentified impurities in the specimens. (ATD)

21078 EFFECT OF X RADIATION ON GERMANIUM AND GERMANIUM P–N JUNCTIONS. III. EFFECT OF X RAYS ON GERMANIUM P–N JUNCTIONS. Krivov, M. A.; Malyanov, S. V. (Siberian Physical-Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 118-21(1966). (In Russian).

The influence of x rays on p–n junctions of commercial germanium diodes type D7Zh and D1602V, and on laboratory-produced germanium p–n junctions was investigated. To eliminate the additional photoeffect, all the investigations were made in a dark room and the junctions were wrapped in black paper. The experiments have shown that the x rays cause the inverse branch of the volt–ampere characteristic to change noticeably. The photoelectric increment of the inverse current is independent of the resistivity of the base and is determined by the parameters of the incident x rays. Its increase can be attributed to the increase of the minority-carrier density by the x rays. The dependence of the current on the absorbed incident dose is similar to the relaxation curves previously observed in the carrier density of x irradiated germanium. The forward branch of the volt–ampere characteristics of germanium p–n junctions is not noticeably altered by the x rays. Whatever changes occur are connected with the change in the mobility of the carriers under the influence of the x radiation. The tests have also shown that the forward current depends on the specific resistivity of the base, which is also altered slightly by the exposure to x rays. The forward current decreases with the absorbed dose when the ratio of the thickness of the base to the diffusion length is small, and increases with the absorbed dose when this ratio is large. The changes in the forward and inverse currents have a strong effect on the rectification coefficient, which decreases strongly with increasing dose. (ATD)

21079 HEAT OF FORMATION OF SOLID SOLUTIONS AND ENERGY STORED IN THEM DURING IRRADIATION BY PROTONS. Zavadovskaya, E. K.; Kuz'mina, A. V.; Golovchanskii, E. M. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 165-7(1966). (In Russian).

Results of a study of the heat of formation of solid solutions of the KCl–KBr system as a function of the composition of the solid solution and analysis of the kinetics of stored-energy buildup in solid solutions of this system after irradiation by protons are reported. It is found that the magnitude of the stored energy after irradiation by protons is greater in KBr and KCl crystals than in their solid solutions. It is noted that, while stored-energy buildup occurs in two distinct stages (a fast and then a slow stage) in KBr and KCl crystals, the buildup in their solid solutions occurs slowly and according to a linear law from the very beginning of irradiation. The stored energy in the solid solutions after proton irradiation is found to amount to 20% of the heat of formation of the solutions. (Int. Aerospace Abstr.)

21080 NEUTRON SCATTERING IN A FERROMAGNETIC CRYSTAL CONTAINING IMPURITIES WITH NEGATIVE EXCHANGE COUPLING. Izyumov, Yu. A.; Medvedev, M. V. (Inst. of Metal Physics, Kiev. Ural State Univ., Sverdlovsk, USSR). Fiz. Metal. Metalloved., 22: 801-9(Dec. 1966). (In Russian).

This work is a continuation of a previous investigation (Zh. Eksp. Teor. Fiz., 51: 517(1966)) dealing with the spin–wave theory of a ferromagnetic crystal containing an impurity atom with negative exchange coupling with the matrix, with the difference that it deals with the theory of the inelastic scattering of neutrons in a ferromagnetic crystal containing a small concentration of impurity atoms with a spin and exchange integrals differing in value from those in the original crystal. (Owing to zero oscillations in the spin-system, the fundamental state of such a crystal is characterized by nonuniform distribution of spin projections onto the direction of the spontaneous moment about the impurity atom. Then the spin projection of the antiferromagnetic aligned spin does not equal in absolute figures its maximum value S′ and is somewhat shorter, this contraction being compensated by the overall spin contraction of the atoms of the matrix. An investigation of magnetic noncoherent elastic scattering of neutrons on such crystals in the presence of low-impurity concentrations, in the small-angle region, makes it possible in principle to determine the form factor of the nonuniform distribution of the magnetic moment in the neighborhood of the defect. An experimental determination of the inelastic neutron scattering cross sections in such a crystal would make it possible to investigate the structure of spin excitations in the crystal. Here, however, this question is investigated theoretically alone.) The case of negative exchange coupling between the impurity and the matrix is considered, with the impurity spin in the fundamental state being oriented in a direction antiparallel to the direction of the magnetic

order of the matrix. Compared with the case of ferromagnetic impurity, neutron scattering in such a crystal displays a specific feature; the noncoherent part of the cross section has a sharp peak even at transition energies lying within the quasicontinuous spectrum region, because states of a special kind, whose excitation enhances the spontaneous moment of the crystal, participate in the scattering. Recording this peak makes it possible to determine the exchange integral impurity matrix. (ATD)

21081 DETERMINATION OF THE ELECTRON ENERGY LOSSES IN CESIUM. Hartley, B. M. (Univ. of Western Australia, Perth). Phys. Lett., 24A: 396-7(Mar. 27, 1967).

Surface and volume plasmon energies of 2.11 and 2.96 eV and energy losses of 20.1 and 42.8 eV are measured in the characteristic electron energy-loss spectra of cesium. (auth)

21082 THERMAL ANNEALING OF LOW-TEMPERATURE X-IRRADIATED KCl. Behr, A.; Peisl, H.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 24A: 379-80(Mar. 27, 1967).

Thermal annealing of lattice defects in KCl X-irradiated at liquid-helium temperature was studied by optical absorption measurements. The annealing behavior of the α and 195-nm bands, and of the F and H bands, respectively, can be interpreted as recombination of vacancies and interstitials. (auth)

21083 POSSIBILITY OF OBSERVING CHARACTERISTIC ENERGY GAIN BY FAST ELECTRONS IN SOLIDS. Ritchie, R. H. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Lett., 24A: 348-9(Mar. 27, 1967). (ORNL-P-2876).

It is shown that photon absorption by a fast electron may occur with appreciable probability through the intermediary of a virtual plasmon. An estimate shows that it may be feasible to observe this process experimentally. (auth)

21084 MOESSBAUER EFFECT INVESTIGATION OF THE CRYSTALLINE ELECTRIC FIELD IN THULIUM METAL. Uhrich, D. L.; Genin, D. J.; Barnes, R. G. (Ames Lab., Iowa). Phys. Lett., 24A: 338-40(Mar. 27, 1967). (IS-1516).

The crystalline electric field parameters and the total splitting of the $^3H_6$ ground term in thulium metal have been determined above the Néel temperature by a Mössbauer effect investigation of the temperature dependence of the nuclear quadrupole splitting of the 8.42-keV gamma transition of ^{169}Tm. (auth)

21085 RADIATION COLORING OF NaCl SINGLE CRYSTALS ACTIVATED BY TRIPLE-CHARGED NEODYMIUM IONS. Melik-Gaikazyan, I. Ya.; Chervyakova, L. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 172-3(1966). (In Russian).

The effects of a triple-charged, cation-substituted admixture of Nd on the formation of electron centers in NaCl under the influence of x rays were examined. The NaCl single crystals were grown for about 100 hr in evacuated quartz ampoules. The batch was prepared from $NdCl_3$ and from purified NaCl. The irradiation was performed with a URS-55A x-ray machine with a Cu anticathode operating at 45 keV and 12 mA. The chemical concentration of Nd in NaCl:Nd crystals was within 1.15×10^{-3} to 4.3×10^{-4} percent by weight. The varying content of Nd in the crystal may decrease or increase the formation rate of F centers. Thus, the absorption coefficient at the maximum of the F band at Nd concentrations of ~0.08% (molar) may increase by a factor of 1.5; with admixture content of ~0.05% (molar), the absorption coefficient decreases almost by a factor of three. It appears that the electron localization related to the admixture is more intense in crystals activated by rare earth ions; thus the coloring of NaCl:Nd^{+++} is lower than the coloring of pure NaCl. (ATD)

21086 RECOMBINATION LUMINESCENCE KI:Tl PHOSPHOR. Parfianovich, I. A.; Krongauz, V. G. (Irkutsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 7-11(1966). (In Russian).

A study was made of the x-ray luminescence and optical flash of several samples of KI:Tl containing different amounts of an activator, excited by x rays at T = 105°K. Pulse measurements of the temperature dependence between the brightness of the flash and x-ray luminescence were found to be complex, and a series of alternating increases and decreases in these values was observed between the temperatures 105 and 240°K. At the same time a pronounced parallelism was observed in variations in brightness and x-ray luminescence within this temperature range. The increase in flare brightness and in x-ray luminescence following the heating of excited samples from 105 to 133°K is discussed. The regularities observed are explained, taking into account the redistribution of hole centers. The data obtained point to the importance of the electron-hole mechanism in the migration of energy from the basic substance to the centers of luminescence in KI:Tl phosphors. (auth)

21087 PLASMON EXCITATIONS IN NUCLEAR MAGNETIC RESONANCE. Gunther, L.; Revzen, M.; Ron, A. (Israel Inst. of Tech., Haifa). Physics, 3: 115-27(Feb. 1967).

A theory is presented to account for the recently observed anomalous peak in the nuclear magnetic relaxation rate ($1/T_1$) in n-doped InSb. The magnitude of the magnetic field at the peak has been found to satisfy the equation $\omega_s = \omega_p$, where ω_s and ω_p are the spin-flip energy and plasma frequency of the electrons, respectively. Furthermore, the peak occurs at a field such that only the spinup, lowest Landau level is occupied (at T = 0°K). The theory discusses the anomalous peak as being due to plasmon absorption and emission by electrons as an intermediate step in the mutual electron-nucleus spin-flip process and predicts a logarithmic singularity in $(1/T_1)$ at $\omega_s = \omega_p$. (auth)

21088 UNIAXIAL ANISOTROPY AND ROTATIONAL HYSTERESIS IN THIN GADOLINIUM FILMS. Livesay, B. R.; Grismore, F. L.; Scheibner, E. J. (Georgia Inst. of Tech., Atlanta). J. Appl. Phys., 38: 1438-9(Mar. 1, 1967).

The planar anisotropy and rotational hysteresis of thin films of gadolinium have been studied using torque measurements. Films ranging from 300 to 700 Å were prepared by evaporation at normal incidence onto heated quartz and glass substrates and overcoated with SiO. Electron- and x-ray-diffraction patterns show a finite fraction of crystallites have a canted preferred orientation of the c axis, which probably accounts for the uniaxial anisotropy observed. The films were found to have a dominant sin 2θ-torque behavior for fields above 3 kOe and a sin θ dependence below 300 Oe. The uniaxial anisotropy constants measured for these films are 10^4 to 10^5 erg/cc. The films show a unidirectional rotational hysteresis. Peak loss occurs at field strengths between 0.5 and 1 kOe, and losses remain significant up to 10 kOe. A magnetic model based on a magnetization ripple structure is proposed to explain the observed data. (auth)

21089 MAGNETIC SYMMETRY AND SPIN WAVES. Brinkman, William (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 38: 939-43(Mar. 1, 1967).

In general, the symmetry of the spin-wave spectra is determined by the magnetic space group characteristic of the spin order in the crystal. For many magnetic materials, however, interactions such as dipole-dipole, antisymmetric exchange, and higher-order anisotropic exchange are quite small, so that most of their properties are essentially determined by isotropic Heisenberg exchange plus a few crystal field parameters. It was pointed out previously that this fact is reflected in the spin-wave spectra in terms of additional symmetry not predicted by the magnetic-space-group theory and that this symmetry is describable in terms of spin-space groups, which include independent spin and space rotations. In this paper the theory of magnetic space groups and spin-space groups and the characterization of the spin-wave spectra in terms of their representations is briefly reviewed. The effect on the spin-wave spectra of the various types of interactions that have been proposed for the rare earth metals is then analyzed in detail and compared with the recent experimental data for Tb. The calculation of selection rules for neutron scattering is also discussed and applied to Tb. (auth)

21090 NEUTRON-DIFFRACTION STUDIES OF TERBIUM. Arrott, A. (Ford Motor Co., Dearborn, Mich.); Werner, S. A.; Cooper, M. J.; Nathans, R.; Shirane, G. J. Appl. Phys., 38: 969-70(Mar. 1, 1967).

A neutron-diffraction study of antiferromagnetism and the wave-vector-dependent susceptibility of Tb near its Néel temperature shows a susceptibility that can be represented over a range of temperatures by $\chi_q^{-1} = \chi_Q^{-1} + (q_z - Q)^2/(eq_0)^2 + (q_x^2 + q_y^2)q_0^2$ with e = 2.6 and $q_0 = 0.017$ $(4\pi b_3)$ and with a χ_Q that roughly follows the expression $[(T - T_N)/T_1]^{-\frac{1}{3}}$, with $T_1 = 6$°K. There is a more rapid decrease in χ_q than predicted by the Lorentzian form for large values of $(q_z - Q)$ and a less rapid decrease than predicted for large values of q_x. The wave vector for which χ_q is a maximum shifts farther away from ferromagnetism the higher the temperature. (auth)

21091 INELASTIC NEUTRON SCATTERING BY DENSITY FLUCTUATIONS IN CO_2 NEAR THE CRITICAL POINT. Bata, L.; Kroo, N. (Central Research Inst. for Physics, Budapest). Phys. Lett., 24A: 57-8(Jan. 2, 1967).

Density fluctuations are studied by inelastic neutron scattering in CO_2 above the critical temperature. The effect of adiabatic and isobaric fluctuations can be seen. (auth)

21092 CRYOSTAT FOR COLOR CENTER STUDIES. Neubert, Theodore J.; Sydejko, Joseph F. (Illinois Inst. of Tech., Chicago). Rev. Sci. Instrum., 38: 559-60(Apr. 1967).

A simple and inexpensive cryostat is described, which takes optimal advantage of glass and metal construction, and is mainly used in the study of color center. (B.G.D.)

21093 SOLID STATE PHYSICS. VOLUME 19. ADVANCES IN RESEARCH AND APPLICATIONS. Seitz, Frederick; Turnbull, David (eds.). Solid State Phys., 19: 1-381(1966).

Four articles on the following subjects are included: theoretical and experimental aspects of the effects of point defects and disorder on the vibrations of crystals, x-ray-diffraction studies of the lattice parameters of solids under very high pressure, transient and residual effects of shock waves on solids, and present status of the theory for the interaction between acoustic phonons and conduction electrons. (A.G.W.)

21094 INVESTIGATION ON THE SCINTILLATION BEHAVIOR OF CsI WITH REGARD TO ITS USE FOR PARTICLE DISCRIMINATION. Siemer, J.; Langkau, R. (Institut fuer Experimentalphysik, Hamburg). Z. Naturforsch., 21a: 2089-92(Dec. 1966). (In German).

With the help of the Bollinger–Thomas method the scintillation fading of CsI crystals with various Tl concentrations in the temperature region from –160 to +145°C was investigated with regard to particle discrimination. Alpha particles and gamma quanta served for scintillation excitation. The quality of particle discrimination at room temperature for crystals of various Tl contents was proven by the zero-transmission method. (tr-auth)

21095 ADIABATIC CALORIMETER FOR MEASUREMENT OF STORED ENERGY OF ALUMINUM AFTER NEUTRON IRRADIATION AT 4.6°K. Schilling, W.; Tischer, P. (Technische Hochschule, Munich). Z. Angew. Phys., 22: 56-63(1967). (In German).

The construction and working of an adiabatic calorimeter is presented, with which the stored energy of aluminum was measured after neutron irradiation in the Munich Research Reactor FRM. The total stored energy after an irradiation dose of 8.6×10^{17} n/cm^2 ($E_n > 0.1$ MeV) is 4.6 Wsec/g; a corresponding change in electrical resistivity is 135.1×10^{-9} Ω-cm. For recovery stage I the spectrum of activation energies is derived from the resulting curves. This spectrum is compared with a spectrum derived from resistivity measurements after deuteron irradiation. (auth)

21096 F_3^+ COLOR CENTER IN LiF. Baumann, G.; von der Osten, W.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Z. Angew. Phys., 22: 246-8(1967).

The splitting behaviour of the 4875 Å zero-phonon line γ-irradiation LiF single crystals under uniaxial stress is studied in absorption and emission. The numbers, intensities, and polarizations of the components into which the line splits under stress along different directions indicate the line to be due to a transition of a trigonal color center. The ground state of the center is nondegenerate, the excited state is doubly degenerate. The line is suggested to be associated with the ionized R center. This result is supported by measurements of reaction kinetics. Both the absorption and the emission zero-phonon line are accompanied by a phonon-assisted structure. (auth)

21097 CONTRIBUTION TO THE THEORY OF FLUCTUATIONS AND SCATTERING OF SLOW NEUTRONS IN FERROMAGNETS. Akhiezer, I. A.; Bolotin, Yu. L. (Ukrainian Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz., 52: 787-97 (Mar. 1967). (In Russian).

Fluctuations and scattering of slow neutrons in ferromagnets are investigated. Expressions for correlators of fluctuations of quantities characterizing the ferromagnet (e.g. magnetic field strength, magnetic induction, magnetic moment, density, displacement vector) are derived near the ferroacoustic resonance point as well as far from it. It is shown that the correlation functions possess sharp maxima near the frequencies of the eigen oscillations of the crystal, i.e., the spin and sound waves. Far from ferroacoustic resonance the fluctuations of magnetic quantities (magnetic field strength and induction, magnetic moment) are large on the spin waves whereas fluctuations of nonmagnetic quantities (density, displacement vector) are great on the sound waves. Fluctuations of magnetic as well as nonmagnetic quantities are great near ferroacoustic resonance. Scattering of slow neutrons in a ferromagnet is examined taking into account interaction between the magnetic moment oscillations and elastic waves. It is shown that on approach to the ferroacoustic resonance point two closely spaced maxima appear in the neutron scattering differential cross section instead of a single pronounced maximum due to neutron scattering on the spin wave. The coupling between elastic and spin waves manifests itself also in the scattering of slow neutrons on sound oscillations. The scattering cross section in this case may be several times greater than that for an ordinary (non-ferromagnetic) crystal. (auth)

21098 FURTHER EXPERIMENTS ON THE BLOCH–SIEGERT EFFECT. Carrelli, A.; Brescia, G.; Grossetti, E. (Univ., Naples). Ann. Phys. (7), 19: 205-9(1967).

It is shown that fields of perturbing radiofrequency (obtained by modulating the radiofrequency field), besides producing a displacement of frequency of the line of resonance in nuclear magnetic resonance (the Bloch–Siegert effect), also produce variations of intensity between the line of nuclear resonance and the line due to the perturbing fields when the three lines are partially superimposed. (auth)

21099 COMMENTS ON THE STUDY OF THE ZEEMAN EFFECT IN Sm I. Ganiel, U. (Weizmann Inst. of Science, Rehovoth, Israel). Z. Phys., 200: 419-20(Mar. 14, 1967).

Some recent results on the Zeeman effect in SmI by Heilig et al. are discussed. Using a theoretical analysis of the spectrum of SmI by Racah and Ganiel, it is found that some changes in the level assignments are justified. (auth)

21100 THERMAL ANNEALING BEHAVIOR OF RADIOIODINE RECOILS FORMED BY HIGH-ENERGY PROTON IRRADIATION OF CESIUM CHLORIDE. Dema, I. (Inst. of Atomic Physics, Bucharest); Zaitseva, N. G. Rev. Roum. Phys., 11: 573-84(1966).

A study was made on the thermal annealing behavior of the radioiodine recoils formed by irradiation of cesium chloride with high-energy protons at different doses. The results obtained are discussed from the viewpoint of theories accounting for the phenomena of the annealing of defects in irradiated alkali halide crystals. The kinetics of the thermal annealing is also discussed on the basis of the theories that predict a diminution of the activation energy proportional to the number of defects. (auth)

21101 ENERGY STRUCTURE OF CASCADE AND CORRELATED ATOM–ATOM COLLISION CHAINS. Pugacheva, T. S.; Lenchenko, V. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 5, 76-81(1966). (In Russian).

The type of crystal structure is analyzed and the energy structure is determined for atom–atom collision cascades in solid bodies. The function $S(E,\epsilon)$ is introduced to determine the number of collisions initiated by primary atoms of energy E. This leads to the integral equation $S(E,\epsilon) = \delta(E-\epsilon) + \int_0^E S(E',\epsilon)\,[1 - W_k(E)']\,G(E,E')dE'$ where G and W are probability functions. For a solid-sphere potential G is given simply by E^{-1} and the above equation is integrated immediately. A more general method is also described. The atom–atom collision chain distributions are calculated. Curves are obtained for Cu <110> showing combinations of initial magnitudes of angle and energy for which the chain length has an exact, given magnitude. (ATD)

21102 PROTON TRAPPING IN TiO_2 AND SIMPLE OXIDES. Roy, R.; Greer, R. T. (Pennsylvania State Univ., University Park). Solid State Commun., 5: 109-11(Feb. 1967).

A series of simple oxides have been bombarded with 1- to 5-MeV protons in an attempt to find the condition under which surface materials may trap protons. Evidence from infrared spectra was only obtained for trapping by TiO_2, in which an obvious charge balance mechanism exists. No proton retention was detected in MgO, Al_2O_3, the clays, etc. although there is some indication of change in the latter. The study was undertaken in connection with the possible absorption and retention of solar wind protons in various lunar minerals, and the bearing of this on water resources on the moon. (UK)

21103 TEMPERATURE-DEPENDENT ISOMER SHIFT AND ANHARMONIC BINDING OF ^{119}Sn IN Nb_3Sn. Shier, J. S.; Taylor, R. D. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Solid State Commun., 5: 147-9(Feb. 1967). (LA-DC-8430).

A study of the temperature dependence of the Mössbauer recoil-free fraction and the line shift of ^{119}Sn in Nb_3Sn is described. The results indicate anharmonic binding and a temperature-dependent band structure. (auth)

21104 USE OF COLOR FILM IN THE STUDY OF PROTON CHANNELLING. Nelson, R. S.; Farmery, B. W.; Dearnaley, G.; Mitchell, I. V. (Atomic Energy Research Establishment, Harwell, Eng.). J. Mater. Sci., 2: 171-2(1967).

A technique is described which uses colour film to provide semiquantitative energy analysis as well as information on the spatial distribution of protons emerging from thin single-crystal foils. Characteristic star patterns, which are produced when a well-collimated proton beam is incident parallel to a major crystal direction, appear red on a yellow background, and show clearly the two distinct energy groups corresponding to the channelled and random components. (auth)

21105 MAGNETISM IN SOLIDS. Martin, D. H. Cambridge, Mass., Massachusetts Institute of Technology Press, 1967. 452p. $22.50.

The occurrence of ferromagnetism, ferrimagnetism, and anti-

ferromagnetism among materials of many kinds and the empirical characterization of these classes by neutron diffraction, nuclear magnetic resonance, electron resonance, and traditional methods are surveyed. The quantum mechanical bases essential for magnetism, particularly the use of spin operators, are presented. All the categories of paramagnetism and diamagnetism shown by disordered, weakly magnetic substances are considered. An extensive presentation of molecular-field models of magnetic order is included. The nature of exchange forces in a simple molecular system are examined, and the discussion is extended to the several kinds of exchange interaction in solids. The excited states of magnetically ordered solids, including spin-wave and cluster approximations, and the statistical mechanics of magnetic ordering are discussed. (300 references). (A.G.W.)

Theoretical Physics

Refer also to abstracts 20738, 20745, and 21289.

21106 FURTHER REMARK ON UNCERTAINTY RELATIONS. Kraus, K. (Philipps Univ., Marburg, Ger.). Z. Phys., 201: 134-41(1967).

As pointed out earlier (Z. Phsik 188, 374(1965)), the commutation relation $1/i\ [A,B] = C$ (1) for quantum mechanical observables A, B, and C by itself does not imply the uncertainty relation $\Delta A \cdot \Delta B \geqq \frac{1}{2}\,|\overline{C}|$. (2) A, B, and C are assumed to be generators of a unitary representation of a suitable Lie group, such that (1) is implied by the group structure. This assumption is then sufficient to yield (2). (auth)

21107 PROBLEM OF TWO ROTATING BODIES IN THE RELATIVITY THEORY. Racine, C. (Loyola Coll., Madras). Proc. Nat. Inst. Sci. India, Pt. A, 32: 153-8(Mar. 1966).

The existence of an Einstein's static space–time has been proved (Racine 1965) in the case of a rotating fluid contained in a massless shell of negligible thickness. It is shown that in the case of two such bodies and under some restrictions there is no regular static space–time. (auth)

21108 ANALYTIC CONTINUABILITY OF WAVE FUNCTIONS. Lawrynowicz, Julian; Wojtczak, Leszek (Inst. of Mathematics, Polish Academy of Sciences, Lodz. Univ. of Lodz, Poland). Ann. Phys. (7), 19: 76-83(1967).

The general form of a wave equation which in particular may be a Schrödinger, Dirac, Klein–Gordon equation is discussed. Under certain assumptions the necessary and sufficient condition is obtained for analytic continuability of its solutions considered as meromorphic functions. Next, some general formulas in the scattering theory are determined for a potential of arbitrary symmetry. The values of scattering matrix elements are determined by the wave functions for the discrete energy spectrum and by their analytic continuations. The theoretical results are applied to the deuteron disintegration problem and the phase-shift calculation for a modified Yukawa potential. (auth)

21109 GRAVITATIONAL RADIATION. Weber, J. (Univ. of Maryland, College Park). Phys. Rev. Lett., 18: 498-501(Mar. 27, 1967).

The results of two years of operation of a 1660-cps gravitational-wave detector are reviewed. The possibility that some gravitational signals may have been observed cannot completely be ruled out. New gravimeter-noise data enable one to place low limits on gravitational radiation in the vicinity of the earth's normal modes near one cycle per hour, implying an energy–density limit over a given detection mode smaller than that needed to provide a closed universe. (auth)

21110 ON FACTORIZATION OF EINSTEIN'S FORMALISM INTO A PAIR OF QUATERNION FIELD EQUATIONS. Sachs, M. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 47A: 759-69(Feb. 21, 1967).

It is proposed that a full exploitation of the principle of general relativity in the construction of the metrical field equations implies that the fundamental variables should be quaternion fields rather than the metric tensor field of the conventional formulation. Thus, the tensor property of Einstein's formalism is replaced here by a formalism that transforms as a quaternion—a vector field in coordinate space and a second-rank spinor field of the type $\eta \otimes \eta^*$ in spinor space. The geometrical field variables of the Riemann space are derived in quaternion form. The principle of least action (with the Palatini technique) is then used to derive a pair of time-reversed quaternion field equations, from the (quaternionic form of) Einstein's Lagrangian. It is then shown how the conventional tensor form of the Einstein formalism is recovered from a particular combination of the derived time-reversed quaternion equations. (auth)

21111 EVALUATION OF FOUR GENERAL-RELATIVITY TESTS FOR A NEARLY FLAT SPACE WITH SPHERICAL SYMMETRY. Brigman, G. H. (General Dynamics, Fort Worth, Tex.). Nuovo Cimento (10), 48A: 686-702(Apr. 1, 1967).

The phenomenological-metric method is applied to four tests of general relativity. The difficulty in attaching meaning to an r co-ordinate obstructs the process of determining deviations from flatness by this method. An attempt to alleviate this difficulty by using idealized models of flat and curved space–time does simplify the partial evaluation of the metric of the curved space–time for first-order effects, but the flaw in the definition of the r co-ordinate persists unless the curved space–time is actually flat in the region of interest. (auth)

21112 CLASSICAL AND QUANTUM SYSTEMS WITH TIME-DEPENDENT HARMONIC-OSCILLATOR-TYPE HAMILTONIANS. Lewis, H. R. Jr. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 18: 510-12(Mar. 27, 1967). (LA-DC-8455).

The unifying feature of the physical systems discussed is the existence of a Hamiltonian of the form $H = (1/2\epsilon)[p^2 + \Omega^2(t)q^2]$, where q is a canonical coordinate, p is its conjugate momentum, $\Omega(t)$ is an arbitrary continuous function of t, and ϵ is a positive, real parameter. The original motivation for considering such systems was the desire to investigate the nature of the magnetic-moment series for a charged particle moving nonrelativistically in the relatively simple electromagnetic field for which the scalar potential is 0 and the vector potential is $\vec{A} = \frac{1}{2}h(t)\vec{B}_0 \times \vec{r}$, where h(t) is a function of time, $\vec{B}_0$ is a constant vector, and $\vec{r}$ is the position vector; with this vector potential the magnetic field, $\vec{B}(t)$, is given by $h(t)\vec{B}_0$. The equations of motion for such a particle can be reduced to the equations corresponding to the Hamiltonian of the above equation exactly, in which case $\Omega(t)$ is $\frac{1}{2}B(t)$, and ϵ is the ratio of mass to charge. (auth)

21113 WAVE FUNCTIONS DEFINED ON A RIEMANN VARIETY V_5 ADMITTING LOCALLY THE CONFORM SU(2,2) AS ISOMETRIC GROUP. Gueret, Philippe; Vigier, Jean-Pierre (Institut Henri Poincare, Paris). Compt. Rend., Ser. B, 264: 271-3(Jan. 23, 1967). (In French).

In a previous study the hyperbolic sphere with five dimensions, Σ_5, was used as Riemann variety V_5, admitting the isometric group $G_{15} \sim SO(4,2)$. This group is locally isomorphous to SU(2,2) which contains SU(2,1) as a subgroup. From this fact, Σ_5 is suitable for the study of the maximumly degenerated representations of SU(2,2) and of complete representations of SU(2,1). In order to interpret these results physically the explicit forms of the solutions of the Laplace–Beltrami equations on this variety are studied. (tr-auth)

21114 ILLUSTRATIVE REPRESENTATION OF THE LORENTZ–EINSTEIN METRIC OF AN INERTIAL SYSTEM AND SOLUTION OF THE LENGTH CONTRACTION PARADOX. Raab, I. (Univ. of Innsbruck). Acta Phys. Austr., 24: 210-18(1966).

This study is based on studies of Ahrens (Am. J. Phys., 29: 34(1961)) and gives an illustrative representation of the Lorentz–Einstein metric of an inertial system. The mutual length contraction is considered and an illustrative and correct solution of the length contraction paradox of Rindler (Am. J. Phys., 29: 365(1961)) is given. (auth)

21115 ON THE EINSTEIN–BOHR [1] IDEAL EXPERIMENT. Halpern, Otto (American Express Co., Vienna). Acta Phys. Austr., 24: 274-9(1966).

A detailed discussion of the well-known ideal Einstein–Bohr experiment leads to the result that the uncertainty principle is not violated by EINSTEIN's experiment. This is shown to be true even if one neglects the inaccuracies which BOHR derived with the aid of formulae for redshift phenomena. It is shown that (a) the uncertainty principle holds true as mentioned already in absence of redshift phenomena; (b) redshift phenomena could be avoided by simple modification of the apparatus; (c) the formula for the time inaccuracy given by BOHR will hardly ever, if at all, hold true. (auth)

21116 UNCERTAINTY PRINCIPLE. Halpern, Otto (American Express Co., Vienna). Acta Phys. Austr., 24: 280-6(1966).

The various foundations of the uncertainty principle are analyzed. It is shown that although there cannot be any doubt about its validity, the uncertainty principle has hardly been derived rigorously. In particular the formulation of the uncertainty principle which involves the time and is connected with it the relativistic formulation gives rise to difficulties. Several examples, previously published are discussed with the purpose of showing how the uncertainty principle applies particularly to cases where an inaccuracy in time exists. The difficulties in this last case are analyzed for the well-known Einstein–Bohr ideal experiment. It is furthermore discussed how, in the case of relativistic quantum mechanics, even individual observables can no longer be measured with arbitrary accuracy. The role of the

uncertainty principle in the present state of physics is elucidated by a historical fantasy about the invention of relativity. (auth)

21117 EINSTEIN EQUATION AND THE MOTION EQUATION FOR A CONTINUUM IN THE HIGH-VELOCITY APPROXIMATION. Kuehnel, Adolf (Karl-Marx-Univ., Leipzig). Wiss. Z. Karl-Marx-Univ., Leipzig, Math.-Naturwiss. Reihe, 13: 485-8 (1964). (In German).

A method was developed by Bertotti and Plebanski for the high-velocity approximation within the framework of the Einstein gravitational theory using the generalized Green functions. A graphic representation was given in this method for the expressions occurring in the individual orders. In the present study this graphic representation is generalized for a continuum. (J.S.R.)

21118 ON A POST-GALILEAN TRANSFORMATION APPROPRIATE TO THE POST-NEWTONIAN THEORY OF EINSTEIN, INFELD, AND HOFFMANN. Chandrasekhar, S.; Contopoulos, G. (Univ. of Chicago. Univ. of Thessaloniki, Salonika). Proc. Roy. Soc. (London), Ser. A, 298: 123-41(Apr. 4, 1967).

It is shown that the line element, which forms the basis of the post-Newtonian theory of Einstein, Infeld, and Hoffmann for the motion of mass points under their mutual gravitational attractions, is invariant in form to a certain post-Galilean transformation. It is necessary that the transformation, expressed as an expansion in inverse powers of c^2 (c is the velocity of light), include terms of $O(c^{-2})$ in the transformation for the spatial coordinate and terms of $O(c^{-4})$ in the transformation for the time coordinate. Comparison with the Lorentz transformation (between two frames in uniform relative motion with a velocity V), expanded similarly in inverse powers of c^2, shows (1) that the spatial part of the transformation includes the Lorentzian terms [up to $O(c^{-2})$] and allows, in addition, an arbitrary rotation, a uniform motion, and a shift of the origin [all of $O(c^{-2})$] and (2) that the temporal part of the transformation includes the Lorentzian terms [up to $O(c^{-4})$] and an additional term of purely gravitational origin. It is the presence of this last gravitational term that gives to the transformation its non-Lorentzian character. For a suitable choice of the constants in the post-Galilean transformation, the parameter V can be interpreted as a velocity of relative motion between the two frames, even as in the Lorentz transformation. The invariance of the form of the line element to the transformation ensures that the equations of motion which follow are similarly invariant to the transformation. This fact is further verified by showing that the Lagrangians in the two frames differ by the total derivative of a function. The relations between the ten constants of the motion in the two frames are determined, and the special case when the transformation can be regarded as appropriate to a "centre of mass system" is briefly considered. (auth)

21119 RELATIVISTIC SCALAR HYDRODYNAMICS. Tam, Kwok-kee (Loyola Coll., Montreal). Can. J. Phys., 45: 1415-17(Mar. 1967).

A variational principle for an inviscid, relativistic charged fluid was previously considered (Tam 1966). Bearing in mind the possible application of the hydrodynamic theory for a system of particles interacting through a scalar field to nuclear and astrophysical problems, the variational principle is extended to relativistic, scalar hydrodynamics. (W.D.M.)

21120 SOME ASTRONOMICAL EFFECTS OF MULTIDIMENSIONAL GRAVITATIONAL THEORY. Kalitzin, N. St. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 81-90(1966). (In Bulgarian).

The nonstationary solutions of multidimensional gravitational equations in the case of central spherical symmetry developed previously (Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk 15: 91(1966)) are applied to the quasi-periodic phenomena in the solar system. The deviation of the light deflections on the sun from the Einstein value of 1.75'' and the sun activity was investigated on the basis of the multidimensional gravitational theory. (J.S.R.)

21121 MASS AND WEIGHT OF LIGHT. Bodenstedt, Erwin (Univ., Bonn). Bild Wiss., 3: 888-97(Nov. 1966). (In German).

Because light has energy it must also have mass, according to the well-known Einstein equation. Light particles, or photons also must have weight. Methods of measuring these values are discussed. They are difficult to measure, because, for instance, although light must be bent because of the gravitational force of the sun, the curvature is so small the deviation from a straight line is only ~0.005 mm in 300 km. Direct measurement of photon weight by this method has been made through astronomical studies during solar eclipses by measurement of displacement of light from a fixed star that passes by the sun. The mass of the photon can be studied indirectly by measurements of the Compton effect on electrons. For this, hard γ radiation is used. Direct detection and measurement of photon weight in the laboratory can be made by means of the Moessbauer effect. Observation of resonance absorption of γ radiation by atomic nuclei is much more difficult than measurement of resonance absorption of visible light by atomic shells. Within the measurement accuracy of the experimental methods used, the photon weight observed agrees with the theoretical value. (BBB)

21122 SOME REMARKS ON DIRAC'S HYPOTHESIS. Krzywoblocki, M. Z. (Michigan State Univ., East Lansing). Rev. Roum. Phys., 11: 651-4(1966).

It is suggested that Dirac's hypothesis of diminishing gravitation may be associated with a cosmological theory that requires a modification of the steady-state cosmological principle in the following sense: The universe presents the same aspects from any place at any time during a period of time very short in comparison to the unit 2×10^9 years, but it may not present the same aspects at any time during the period of time of the order of the unit 2×10^9 years. A generalized interpretation of Dirac's hypothesis is proposed, and the similarity between Dirac's hypothesis and the most recent cosmological developments is pointed out. (A.G.W.)

21123 CONCEPT OF AN ANOMALOUS GRAVITY FIELD. Aleksidze, M. A. (Calculating Center, Academy of Sciences, Gruz SSR). Dokl. Akad. Nauk SSSR, 170: 828-30(Oct. 1, 1966). (In Russian).

The potential of the real earth is considered to consist of two parts, T and ST. The first part is that which is determined by the Stokes' formula, and the second variable part relates to a layer of variable density, expressed by an integral equation. Molodenskii proposed solving the integral equation by selecting values of anomalies on a sphere σ which satisfy the real anomalies on the surface S of the real earth G. This solution is performed by Aleksidze determining on the surface of a sphere σ a system of anomalies which coincided with the gravity field of the earth and the external field of the variable layer. In this system δT equals zero. A given function T(S) on the surface of the real earth must be solved by aid of a value $t(\tau)$ on the sphere δ under the condition that $\Delta T' = 0$ in the space G; $T' = 0$ in infinity. G_1 is an exterior space connected with the sphere σ, a subset of G. The solution is possible under the condition $|T(M) - T'(M)| < \epsilon$, where ϵ is a positive fraction and M is a point in the potential field. A system of functions $\{1/r(M_i M)\}$, where point M is a subset of S and M_i is a subset of S_1; $r(M_i, M)$ is the distance between these points, can be used for the solution. Normalizing this system and adapting it to the sphere σ, the exterior Dirichlet problem for this function was solved, and an integral correlation between potential fields T and T' was proved. (ATD)

21124 VARIATIONAL METHODS OF CONSTRUCTING MODELS OF A CONTINUOUS MEDIUM WITH IRREVERSIBLE PROCESSES IN THE SPECIAL THEORY OF RELATIVITY. Berdichevskii, V. L. Prikl. Mat. Mekh., 30: 1081-6(Nov.-Dec. 1966). (In Russian).

The following variational principle can serve for the construction of a model of a continuous medium by means of a minimum number of hypotheses: $\delta \int_v \Lambda d\tau + \delta W + \delta W^* = 0$. The construction of the model reduces to assigning the Lagrangian Λ and the functional δW^*. Within the framework of the special theory of relativity, continuous media are considered for which the Lagrangian Λ depends on the following quantities: $\partial x^i / \partial \xi^p \equiv x^i_p$, $\nabla_k x^i_p$, μ^A, $\nabla_i \mu^A$, $\nabla_i \nabla_j \mu^A$, S, K^C and L^C. Here x^i are the coordinates of a fixed curvilinear system of reference of the observer; ξ^p are the coordinates of an associated reference system; the functions $x^i(\xi^p)$ which determine the transfer from the associated reference system to the system of the observer, give the law of motion of the medium; μ^A are the field functions; the scalar S is the entropy measured in his own reference system and referred to a unit of mass at rest; K^C are the components of a number of given, invariant tensors in the observer's system of reference; L^C are the same components in the associated reference system. Expressions are written for δW^* and δW, and equations are obtained describing the behavior of the continuous medium. Models which are determined by assigning the Lagrangian Λ are considered. An ideal compressible liquid and an isotropic elastic medium are taken as examples. The model of a viscous thermally conducting liquid is also considered. (TTT)

21125 GRAVITATIONAL WAVES. Burcev, Petr. Pokroky Mat. Fys. Astron., 11: 364-73(1966). (In Czech).

Starting with a discussion of the possible existence of gravitational waves, it is pointed out that such existence was first predicted by Einstein in 1916. Einstein's prediction was based on analogy between gravitational and electromagnetic fields, but his calculation predicted that the magnitude of such waves would be so small that detection at that time was unthinkable, and indeed such detection remains unattainable. The mathemat-

ical expressions of the linearized theory of gravitational radiation as developed by several theoreticians are reviewed. The possibilities of proving the existence of gravitational waves are discussed and expected frequencies and energies in relation to the sensitivity of existing detectors are examined. A prediction is made that the proof of the existence of gravitational waves will be realized in the not-too-far-distant future. (TTT)

21126 GRAVITON EMISSION BY PHOTONS IN A GRAVITATIONAL FIELD. Boccaletti, D. (Istituto Nazionale di Fisica Nucleare, Bologna); De Sabbata, V.; Gualdi, C.; Fortini, P. Nuovo Cimento (10), 48A: 58-66(Mar. 1, 1967).

The cross section for the emission of a graviton by a photon interacting with an external gravitational field is calculated using the quantum formulation of the linearized equations of general relativity. After showing that the chosen Lagrangian interaction gives the correct formula for the bending of a light beam as predicted by Einstein, the calculation of the matrix element for the emission of a graviton is carried out in detail. It is shown that this interaction is completely negligible and cannot explain, for instance, the cosmological red-shift of light. A more effective process may be the splitting of a photon into three ones in an external gravitational field. (auth)

21127 TWISTOR ALGEBRA. Penrose, R. (London Univ.). J. Math. Phys. (N. Y.), 8: 345-?(Feb. 1967).

A new type of algebra for Minkowski space-time is described, in terms of which it is possible to express any conformally covariant or Poincaré covariant operation. The elements of the algebra (twistors) are combined according to tensor-type rules, but they differ from tensors or spinors in that they describe locational properties in addition to directional ones. The representation of a null line by a pair of two-component spinors, one of which defines the direction of the line and the other its moment about the origin, gives the simplest type of twistor, with four complex components. The rules for generating other types of twistor are then determined by the geometry. One-index twistors define a four-dimensional, four-valued ("spinor") representation of the (restricted) conformal group. For the Poincaré group a skew-symmetric metric twistor is introduced. Twistor space defines a complex projective three-space C, which gives an alternative picture equivalent to the Minkowski space-time M (which must be completed by a null cone at infinity). Points in C represent null lines or "complexified" null lines in M; lines in C represent real or complex points in M (so M, when complexified, is the Klein representation of C). Conformal transformations of M, including space and time reversals (and complex conjugation) are discussed in detail in twistor terms. A theorem of Kerr is described which shows that the complex analytic surfaces in C define the shear-free null congruences in the real space M. Twistors are used to derive new theorems about the real geometry of M. The general twistor description of physical fields is left to a later paper. (auth)

21128 PERTURBATION THEORY AND ITS APPLICATIONS IN QUANTUM MECHANICS. Proceedings of an Advanced Seminar Conducted by the Mathematics Research Center, United States Army, and the Theoretical Chemistry Institute at the University of Wisconsin, Madison, October 4–6, 1965. Wilcox, Calvin H. (ed.). New York, John Wiley and Sons, Inc., 1966. 434p. $6.95. (CONF-651085).

Fourteen papers are included having to do with the subject of perturbation theory for linear self-adjoint operators on a Hilbert space and its applications to problems of theoretical chemistry. A general survey of the ways in which perturbation theory is used to determine physical properties of molecules is presented. Some mathematical problems whose solutions would make possible further progress in the theoretical determination of molecular properties are discussed. New developments in the application of perturbation theory to quantum chemistry are presented. A descriptive survey of the basic mathematics of perturbation theory is presented, concentrating on the phenomena that may be produced by perturbations of operators. New developments in the mathematical theory are covered. (M.H.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstracts 21414--21417, 21422, and 21580.

21129 FORWARD SCATTERING OF GeV PHOTONS FROM CARBON AND TUNGSTEN. Eisenhandler, E.; Mistry, N.; Mostek, P.; Talman, R. (Cornell Univ., Ithaca, N. Y.). Phys. Lett., 24B: 347-8(Apr. 3, 1967).

Small angle (~3°) scattering of GeV photons from carbon and tungsten was measured. The results are compared with the predictions of a simple "optical theorem" model, where the total cross section for photon absorption is taken to be the incoherent sum of absorption on single nucleons. (auth)

21130 EXPERIMENTAL TEST OF A HIDDEN-VARIABLE QUANTUM THEORY. Papaliolios, Costas (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 18: 622-5(Apr. 10, 1967).

Evidence of the hidden variables in quantum theory as suggested by Bohm and Bub is sought. This is done by making appropriate successive measurements within times of the order of 10^{-13} sec in order to distinguish between the two polarization states of the photon. This measurement is performed by means of linear polarizers. Failure to observe the existence of these hidden variables allows an upper bound to be set on their relaxation time. The data taken support the usual quantum mechanical theory, but the results can be interpreted in terms of the Bohm–Bub theory by assuming a suitably short relaxation time for the hidden variables. (J.F.P.)

21131 ELASTIC ELECTRON-PROTON SCATTERING AT MOMENTUM TRANSFERS UP TO 110 fermi^{-2}. Behrend, H. J. (Deutsches Elektronen Synchrotron, Hamburg); Brasse F. W.; Engler, J.; Hultschig, H.; Galster, S.; Hartwig, G.; Schopper, H.; Ganssauge, E. Nuovo Cimento (10), 48A: 140-64(Mar. 1,1967).

Using the internal beam of DESY elastic electron-proton cross sections were measured at various angles between 32 and 130°, and with momentum transfers of q^2 = 39, 60, 80 and 110 fm^{-2}. Two single-quadrupole spectrometers, movable around a common liquid-hydrogen target, were used for analyzing the momentum of the scattered electrons. Cherenkov and shower counters discriminated against pion and low-energy background. As a cross section reference, recoil protons from elastic scattering at q^2 = 10 fm^{-2} were used, with a quantameter serving as an intermediate monitor. The data are consistent with the Rosenbluth formula, giving real form factors G_E and G_M. Both continue to decrease with increasing momentum transfer, but somewhat faster than indicated by measurements performed so far. (auth)

21132 PHOTOPRODUCTION OF ρ AND f MESONS AT ENERGIES UP TO 5.8 GeV. Erbe, R. (Technische Hochschule, Aachen); Reimann, G.; Schuettler, E.; (and others). Nuovo Cimento (10), 48A: 262-70(Mar. 1, 1967).

Photoproduction of mesons (ρ) φ and (f) in the interactions $\gamma + p \rightarrow p + \rho^0$, $\gamma + p \rightarrow N^*_{1238} + \rho^-$, and $\gamma + p \rightarrow p + f$ at photon laboratory energies up to 5.8 GeV is reported. The analyses for these reactions are carried out and the cross sections are given. (J.F.P.)

Weak

Refer also to abstracts 21601 and 21615.

21133 (BNL-11179) THE SIGN OF THE K_L^0–K_S^0 MASS DIFFERENCE. Canter, J.; Cho, Y.; Engler, A.; (and others) (Carnegie Inst. of Tech., Pittsburgh, Pa.). [1966]. Contract AT (30-2)-Gen-16. 10p. (CONF-670109-8). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Annual Meeting of the American Physical Society, New York.

Some recent results of measurements of the sign of the $K_L^0 - K_S^0$ mass difference are reported. The data came from two 600 MeV/c K^+ exposures of the BNL 30-inch bubble chamber filled with deuterium. Neutral K's were produced by the charge exchange reaction $K^+ + d \rightarrow K^0 + p + p$, and the sign of Δm was determined by monitoring the time dependence of neutral K scatters followed by the decay $K_S \rightarrow \pi^- + \pi^+$. (B.G.D.)

21134 DEPOLARIZATION OF NEGATIVE MUONS STOPPING IN LIQUID HYDROGEN. Klem, R. D. (Univ. of Chicago). Contract Nonr 2121(25). Nuovo Cim. (10), 48A: 743-79(Apr. 1, 1967).

The depolarization of negative muons stopping in liquid hydrogen was measured by observing the distribution of μ-e angles for muons decaying in a hydrogen bubble chamber. Checks for impurities established that transfer of muons from hydrogen to impurities could be neglected. A fit of the expression $(N/2)(1 + a \cos\theta)\, d(\cos\theta)$ to the data gives a value $a = -0.0185 \pm 0.0140$ for the asymmetry parameter. For a 100% polarized μ beam, the corresponding residual polarization is 0.056 ± 0.032. This result indicates a depolarizing mechanism other than simple cascade depolarization. Expected mechanisms including Stark mixing and collisional exchange are discussed. Similar measurements for negative muons decaying at rest in liquid deuterium and for positive muons decaying at rest in liquid hydrogen gave $a = -0.0140 \pm 0.0165$ and $a = -0.206 \pm 0.044$, respectively. (auth)

21135 EVIDENCE FOR $M_L > M_S$ FOR NEUTRAL K MESONS. Fischbein, W. L.; Fry, W. F.; Gaidos, J.; Cline, D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Nuovo Cimento (10), 48A: 224-8(Mar. 1, 1967). (COO-881-86).

For the experiment $\bar{K}^0$'s are produced in K^- charge exchange in hydrogen and deuterium, scatter at some proper time, and are observed to decay in the K_s mode. The events were obtained from 825- to 1115-MeV/c K^- beam interactions in a bubble chamber. Histograms of the probabilities for the Fermi and Yang solutions for the sensitivity of the likelihood for each event to the scattering amplitudes are given. For this purpose a series of Monte Carlo experiments simulating the experimental conditions are performed. (J.F.P.)

Strong (Baryon-Induced)

21136 SMALL-ANGLE ELASTIC p–d SCATTERING AT 1 GeV. Chernev, Kh. M.; Markov, P. K. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 875-6(1966).

A deuterized polyethylene target was exposed to a 1-GeV proton beam in order to investigate small-angle p + d scattering. The recoil deuterons were detected by photoemulsion stacks. The differential cross sections were found, and the radius of the interaction was calculated. (J.F.P.)

21137 USE OF A POLARIZED PROTON TARGET FOR THE STUDY OF LOW-ENERGY NUCLEON–NUCLEON INTERACTIONS. Lehar, Frantisek (Czech Technical Univ., Prague); Winternitz, Pavel. Cesk. Cas. Fys., 17: 158-211(1967). (In Czech).

The possible use of a polarized proton target in the investigation of low-energy nucleon-nucleon interactions is reviewed. The reconstruction of the scattering matrix and verification of P-, T- and isotopic invariance are briefly discussed. Possible sources and detectors of polarized particles are discussed. All possible experimental quantities determined from the phase shift analysis are given in graphs for energies of 14.5 and 23.1 MeV. (auth)

Strong (Meson-Induced)

21138 (COO-1195-85) THE $\bar{K}\pi\pi$ SYSTEM IN THE REACTION $K^-p \rightarrow K^-\pi^+\pi^-p$ AT 5.5 GeV/c. Park, Joseph Chul-Hui (Illinois Univ., Urbana. Dept. of Physics). Feb. 1967. Contract AT (11-1)-1195. 264p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

An experiment was performed in which 436,000 exposures were taken using a separated K^- beam and a hydrogen bubble chamber. As a part of this experiment a study of the $\bar{K}\pi\pi$ system in the reaction $K^- + p \rightarrow K^- + \pi^+ + \pi^- + p$ at 5.5 GeV/c was carried out. The following results are obtained in this study: evidence that the Deck mechanism plays a dominant role in $\bar{K}^{*0}$ (890) production leading to a broad enhancement in the $\bar{K}\pi\pi$ system at low mass, no definite evidence for $\bar{K}^{**}$ (1320) production, evidence for $\bar{K}^{**}$ (1430) production with subsequent decay into $\bar{K}^*$ (890) and π, supporting evidence for the recently discovered L(1789) meson, and finally, indications for a new resonance in the $\bar{K}\pi\pi$ system at 2.02 GeV. (auth)

21139 (INR–761/VI/PH) SIX PRONG INTERACTIONS OF 8 GeV/C π^+ IN HYDROGEN. Bardadin-Otwinowska, Maria; Danysz, Marian; Hofmokl, Tomasz; Otwinowski, Stanislaw; Piotrowska, Helena; Sosnowski, Ryszard; Szeptycka, Maria; Wroblewski, Andrzej (Institute of Nuclear Research, Warsaw (Poland)). Nov. 1966. 16p. Dep.

Cross sections for fitted reaction channels are given. Frequencies of single resonance production are calculated, and cross sections for quasi-three-body reactions are estimated. General characteristics of the emission of secondaries are compared with the results obtained at 10 GeV/c π^-p. (auth)

21140 (TID–23785) THE REACTIONS $K^- + p \rightarrow \Sigma^\pm + \pi^\mp$ ($+\pi^0$) NEAR 1755 MeV. Technical Report No. 618. Charlton, Gordon R. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Sept. 1966. Contract AT(40-1)-3491. 141p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

From a hydrogen bubble chamber exposure to a K^- meson beam, the differential cross sections for the reactions $K^- + p \rightarrow \Sigma^\pm + \pi^\mp$ and the total cross sections for $K^- + p \rightarrow \Sigma^\pm + \pi^\mp + \pi^0$ at 902, 929, 947, 960, and 990 MeV/c were measured. Very little momentum dependence of the two body cross sections and of the Σ^+ polarization in this interval is found, the mean polarization being $\overline{\alpha P} \simeq 0.5 \pm 0.1$. From the cross sections the $Y_1^*(1755) \rightarrow \Sigma + \pi$ branching ratio is estimated to be 0.01 ± 0.01. The three body final states are dominated by the excited hyperon states $Y_1^*(1385)$, $Y_0^*(1405)$, and $Y_0^*(1520)$, with no marked momentum dependences apparent. A branching ratio $Y_1^*(1385) \rightarrow \Sigma + \pi$ of 0.08 ± 0.03 is found. Although interference effects which indicate that the sample of $Y_0^*(1520) + \pi^0$ events is contaminated by background amplitudes are observed, the data are in good agreement with earlier results that the $Y_1^*(1755)$ has spin and parity $5/2^-$. (auth)

21141 K^-p ELASTIC SCATTERING AT 10 GeV/c. Aderholz, M. (Technische Hochschule, Aachen); Bartsch, J.; Keppel, E. (and others). Phys. Lett., Part B, 24: 434-7(Apr. 17, 1967).

K^-p elastic scattering at 10 GeV/c is studied on ~3600 bubble chamber events. The elastic cross section is found to be $\sigma_{el} = (3.20 \pm 0.14)$mb and the ratio $\sigma_{el}/\sigma_{tot} = (0.142 \pm 0.006)$, that is below the upper limit of 0.185 suggested in a model by Van Hove. The value of the forward differential cross section is consistent with zero real part to the scattering amplitude. The slope of $d\sigma/dt$ is similar to that for $\pi^\pm$ and greater than that of K^+, with no evidence for shrinkage of the diffraction peak. No events of backward scattering were observed. The Regge-pole model of Phillips and Rarita gives a good fit to the data. (auth)

21142 UPPER LIMIT FOR THE PRODUCTION OF A POSITIVE-STRANGENESS BARYON WITH MASS BETWEEN 938 AND 1432 MeV. Focardi, S.; Ranzi, A. Minguzzi; Monari, L.; Rossi, A. M. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cim. (10), 48A: 845-7(Apr. 1, 1967).

A search was made for the Z^+ in the $K^+ + p \rightarrow Z^+ + \pi^+$ interaction produced in the 81 cm Saclay hydrogen bubble chamber at (778 ± 10) MeV/c. Approximately 50,000 pictures were analyzed, and no events compatible with Z^+ (long or short lifetime) were found. All particles decaying in the chamber were identified as π^+ or K^+. It is concluded that the cross section for Z^+ production is ≤ 2 μb. (L.B.S.)

21143 SEARCH AND INVESTIGATION OF THREE-PARTICLE RESONANCES IN π^-p INTERACTIONS AT THE PION MOMENTUM 4.7 GeV/c. Vetlitskii, I. A.; Guzhavin, V. M.; Kliger, G. K.; Kolganov, V. Z.; Lebedev, A. V.; Lomkatsi, G. S.; Smolyankin, V. T.; Sokolov, A. P.; Sysoev, E. A. Yadern. Fiz., 5: 603-11 (Mar. 1967). (In Russian).

The reaction $\pi^-p \rightarrow \pi^-p\pi^+\pi^-$ at 4.7 GeV/c was investigated by means of the 55-cm hydrogen bubble chamber. An attempt was made to observe three particle decays of the 2645-MeV ($T = 1/2$) and 2825-MeV ($T = 3/2$) isobar states. It is shown that the enhancement (at 2600 ÷ 2800 MeV) observed in the effective mass spectrum of the $p\pi^+\pi^-$ system is not due to these isobars. In the three-pion system a new resonance is found with mass 1630 ± 30 MeV and total width ~100 MeV. Its most probable quantum numbers are found to be $T \geq 1$, $J^P = 1^+$ or 2^-. The A_2-meson is investigated. (auth)

21144 RESONANCE PRODUCTION IN $\Xi K\pi$ AND $YK\bar{K}$ FINAL STATES FROM K^--p INTERACTIONS AT 4.25 GeV/c. Abrams, G. S.; Kehoe, B.; Glasser, R. G.; Sechi-Zorn, B.; Wolsky, G. (Univ. of Maryland, College Park). Contracts AT(40-1)-2504; AEC-ORO-2504-104. Phys. Rev. Lett., 18: 620-2(Apr. 10, 1967).

Three-body final states observed in a bubble chamber exposure to a meson (K^-) beam having a momentum of 4.25 GeV/c and a total path length of 5.4 μb equivalents are reported. It is concluded that the data in the $(\Lambda,\Sigma^0)K^0\bar{K}^0$ final state are consistent with almost 100% quasi-two-body processes, and that at least 40% of the $\Xi(K\pi)^+$ appears as a quasi-two-body reaction. The data also indicate that if higher excited states of the Ξ are being produced in these channels at 4.25 GeV/c, then their cross sections must be small (a few μb at most) unless they are quite broad. (J.F.P.)

21145 REACTION $K^- + p + \omega^0$ AT 3.8 GeV/c. Carmony, D. Duane; Hendricks, T.; Lander, Richard L. (Univ. of California, San Diego, La Jolla). Contract AT(11-1)-Gen-10. Phys. Rev. Lett., 18: 615-17(Apr. 10, 1967).

Observations on events of the type $K^- + p \rightarrow K^- + p + \omega^0$ obtained from a bubble chamber exposure to a beam of 3.8 GeV/c mesons (K^-) are described. Enhanced Y^* production when an ω^0 is produced rather than a nonresonating $\pi^+\pi^-\pi^0$ triplet, $Y^*(1520)$ production in both a peripheral and a nonperipheral fashion, with very little background, and angular distributions similar to those in the reaction $\pi^- + p \rightarrow \pi^- + p + \omega^0$ are found. (J.F.P.)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 20685.

21146 (IA–975) MONTE CARLO PROGRAM FOR INTERACTIONS OF HIGH ENERGY ELEMENTARY PARTICLES IN COMPLEX NUCLEI. Avni, A.; Friedman, M.; Kessler, D.; Shatz, M. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). July 1965. 114p. Dep. mn.

A general Monte-Carlo program is described for the study of elementary particle interactions on complex nuclei. The program is based on the Hofstadter nuclear model. All particles are subject to a potential well (energy independent) and in addition each charged particle is also subject to a Coulomb potential. The nucleons in the nucleus are free according to a momentum distribution. An example of a calculation is given. (auth)

21147 NEW COMBINATORIAL FEATURE OF FEYNMAN GRAPHS. Ramakrishnan, Alladi (Syracuse Univ., N. Y.); Raghavacharyulu, I. V. V. J. Math. Anal. Appl., 18: 175-81 (Apr. 1967).

The problem of the field theoretic diagrams corresponding to a particular pattern and their number is considered. A general solution to the problem is obtained by introducing suitable notation for field theoretic diagrams and Feynman patterns and identifying a pattern with a composition of the integer n familiar in combinatorial analysis. (J.F.P.)

21148 GROUND-STATE OF INTERACTING BOSONS. Kothari, D. S.; Auluck, F. C.; Kumar, Satish (Univ. of Delhi). Proc. Nat. Inst. Sci. India, Pt. A, 32: 159-72(Mar. 1966).

A general expression was derived for the ground-state energy of an assembly of N interacting Bose particles enclosed in a large volume V, the two-particle interaction being of repulsive type. Then three particular cases in which the energy can be evaluated in a finite form are given. The treatment is extended, following Huang, to the case when the two-particle interaction consists of a repulsive part and an attractive part. (auth)

21149 SOLUTION OF A NONLINEAR SPINOR EQUATION. Chepurnykh, G. K. (Vladivostok Polytechnical Inst., USSR). Yadern. Fiz., 5: 688-92(Mar. 1967). (In Russian).

Exact particular solutions of a nonlinear spinor equation with a six-fermion self-interaction are found in the form of a plane wave. It is shown that it is very difficult (or even impossible) to obtain a solution in the form of a plane wave, for a nonlinear spinor equation with a four-fermion self-interaction. (auth)

21150 DIRECT GENERATION OF MONTE CARLO FINAL STATES WITH UNIT WEIGHT. Chandler, J. P.; Tilger, C. A. (Indiana Univ., Bloomington). Nucl. Instrum. Methods, 51: 117-20(1967).

A method is given for generating Monte Carlo final states with unit weight, distributed according to Lorentz invariant phase space. No rejection processes are used, and as a result the computer time to generate one event varies only linearly with the number of particles. A computer program implementing the method is described. (auth)

21151 FINITE SOLUTIONS IN THE THEORY OF NONRENORMALIZABLE INTERACTIONS. Kirzhnits, D. A.; Livshits, M. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 52: 804-13(Mar. 1967). (In Russian).

The charge-differential axiomatic method previously proposed is applied to nonrenormalizable interaction models, e.g., the nonrelativistic model of the vector type and the relativistic four-fermion model in the two-particle approximation with closed fermion loops. It is demonstrated that besides the usual meaningless solution for the scattering amplitude corresponding to the dynamic statement of the problem, an auxiliary solution appears in the axiomatic theory. This solution is finite, nonanalytic with respect to the coupling constant and grows as exp (const. $\sqrt{E}$) along certain directions on the first sheet of the energy complex plane. This solution cannot be derived from the dynamical theory since a nonunitary scattering "semimatrix" $S(t, -\infty)$ corresponds to it. Upon regularization the

auxiliary solution disappears for any finite value of the "cut-off" momentum. (auth)

21152 LEVINSON'S THEOREM IN A SEPARABLE POTENTIAL MODEL. Urrechaga-Altuna, J.; Rojo, O. (Instituto Politecnico Nacional, Colonia Santo Tomas, Mexico). Nuovo Cimento (10), 48A: 107-14(Mar. 1, 1967).

For a separable potential model with bound states present, the scattering phase shifts are explicitly determined and Levinson's theorem is proved. (auth)

Electromagnetic

Refer also to abstracts 20745, 20772, and 21227.

21153 (CEAL-TM-153) EXPERIMENTAL PROGRAM ASSOCIATED WITH THE BYPASS PROJECT. Little, R.; Paterson, J. M. (Cambridge Electron Accelerator, Mass.). Dec. 10, 1965. Contract AT(30-1)-2076. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A summary of the experimental program associated with the proposed colliding beam bypass at CEA is presented. The interaction processes of interest are: $e^+ + e^- \rightarrow e^+ + e^-$, $\rightarrow \mu^+ + \mu^-$, $\rightarrow \gamma + \gamma$, $\rightarrow W^+ + W^-$, $\rightarrow l^{++} + l^{+-}$, and $\rightarrow$ strongly-interacting particles. The interest in the first three lies in testing the predictions of quantumelectrodynamics. The fourth process is of interest for identifying the intermediate vector boson. The fifth process is a search for heavy leptons and the sixth for production of strongly-interacting particles. (B.G.D.)

21154 (JINR-P2-3195) PRAVILA SUMM, SIMMETRII I KVARKOVAYA STRUKTURA TOKOV. (Sum Rules, Symmetry, and the Quark Structure of Currents). Bogolyubov, P. N.; Matveev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 8p. (In Russian). Dep. mn.

The results of the superconvergent dispersion sum rules for the scattering and photoproduction amplitudes of pions on nucleons were rederived by using the baryon currents of particular quark structure. A brief discussion of the properties of such a current is given. (auth)

21155 η DECAY, CURRENT ALGEBRA, AND THE C-NONCONSERVING ELECTROMAGNETIC CURRENT. Adler, Stephen L. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Lett., 18: 519-24(Mar. 27, 1967).

It is shown that in the usual picture of η decay, current algebra, combined with the assumption of a linear matrix element out to the points where pion four-momenta vanish, implies that $\eta \rightarrow 3\pi$ is forbidden. Possible consequences for $\eta \rightarrow 3\pi$ decay if the electromagnetic interactions of the hadrons violate charge-conjugation invariance are investigated, assuming that $\eta \rightarrow 3\pi$ proceeds almost entirely via the KK term. A model is constructed which realizes the postulated commutation relations of $K\mu$, and the C = 1, U-spin singlet, conserved currents which can be formed in this model are examined. The properties of $K\mu$ which were postulated to explain η decay are checked for conflict with other experimental evidence from electromagnetic mass splittings, C-nonconserving decays of ϵ^0 and η, nuclear isobaric-mass formula, and previous current-algebra results. The possibility that a C = 1 electromagnetic current, which does not produce an observable C-nonconserving part in the $\eta \rightarrow 3\pi$ amplitude, may yet be making the dominant contribution to the C-conserving $\eta \rightarrow 3\pi$ mode is concluded. (L.B.S.)

21156 APPROXIMATE SATURATION OF A SUPERCONVERGENCE RELATION FOR PION PHOTOPRODUCTION. Altarelli, G.; Colocci, M. (Univ., Florence). Nuovo Cimento (10), 48A: 573-8(Mar. 21, 1967).

A new superconvergence sum rule is given for one of the pion photoproduction amplitudes. The sum rule is then saturated with the nucleon pole term and the first three pion-nucleon resonances. The results are compared with experiment. (L.B.S.)

21157 REMARKS ON THE η-MESON CUSP EFFECT IN π^0 PHOTOPRODUCTION. Mencuccini, C.; Reale, A. (CNEN, Frascati, Italy). Nuovo Cimento (10), 48A: 579-863(Mar. 21, 1967).

The possibility of a cusp effect of the η on the single-pion production in the $\gamma + p \rightarrow \pi^0 + p$ interaction in the energy region of the second resonance is examined. It is assumed that the quantum numbers of the state through which the η production occurs are $l = 0$, $J = \frac{1}{2}$, $T = \frac{1}{2}$; the multipole mainly involved in π^0 photoproduction is then the electric dipole $E_{0+}^{\pi^0}$. Experimental differential cross sections at $\theta_{\pi^0} = 90°$ in the energy interval 650 to 810 MeV are examined, which give some evidence of a structure at the threshold of the η photoproduction channel. A model for the ηN system in the S_{11} state is constructed to account for this anomaly. It is noted that the calculated anomaly is much smaller than can be argued from experimental data; the perturbation of the $E_{0+}^{\pi^0}$ multipole due to the sharp opening of the η channel is not great enough to account for the shoulder observed at $E_\gamma = 700$ to 740 MeV. The possibility that the ηN resonance could be a P_{11} state or a mixture of states is not ruled out. (L.B.S.)

21158 A SOFT-PHOTON EMISSION APPROACH TO $\pi^0 \rightarrow \gamma\gamma$ AND $\eta \rightarrow \gamma\gamma\pi^0$ DECAYS. Maiani, L. (Istituto Superiore di Sanita, Rome); Preparata, G. Nuovo Cimento (10), 48A: 550-4 (Mar. 21, 1967).

A method of calculating the amplitudes of processes involving the emission of one or more photons in the limit of their zero frequency is proposed, which parallels very closely the analogous methods of treating zero-energy pions. Use is made of the PCTC hypothesis and of the relevant commutation rules of the local U(12) algebra, assuming the absence of Schwinger terms. The decay amplitude for $\pi^0 \rightarrow \gamma\gamma$ is calculated and the lifetime of π^0 was found to be in fair agreement with experimental results. The method is also applied to the process $\eta \rightarrow \gamma\gamma\pi^0$, and the branching ratio $\Gamma(\eta \rightarrow 2\gamma\pi^0)/\Gamma(\eta \rightarrow 2\gamma) \simeq 1.1$ was found. (L.B.S.)

21159 A POLE MODEL FOR $\eta \rightarrow 3\pi$ DECAYS. Silvestrini, V. (CNEN, Frascati, Italy); Maiani, L.; Preparata, G. Nuovo Cimento (10), 48A: 555-9(Mar. 21, 1967).

A simple pole model is presented for the $\eta \rightarrow 3\pi$ decay, which accounts for the low value of the ratio $R = (\eta \rightarrow 3\pi^0)/(\eta \rightarrow \pi^+\pi^-\pi^0)$ and for the observed shape of the distribution in the Dalitz plot, without the need of introducing any sophisticated type of interaction. By assuming SU(3) symmetry and an octet behavior of the electromagnetic current, an estimate for the absolute rate for the decay $\eta \rightarrow 3\pi$ is also obtained. (L.B.S.)

21160 PHOTOPRODUCTION OF VECTOR MESONS AS VIRTUAL VECTOR MESON-PROTON SCATTERING. Freund, P. G. O. (Univ. of Chicago). Nuovo Cimento (10), 48A: 541-4 (Mar. 21, 1967).

A model was previously proposed for vector-meson photoproduction based on the photon-vector meson analogy. A refinement of the model is made in which two previous assumptions are given up and the effects of including the lower Regge trajectories in the analysis and SU(3)-breaking effects at the γV link are considered. (L.B.S.)

21161 CURRENT ALGEBRA AND $\eta \rightarrow 3\pi$, $X \rightarrow 2\pi\eta$ DECAYS. Dolgov, A. D.; Vainshtein, A. I.; Zakharov, V. I. (Academy of Sciences, Moscow). Phys. Lett., Part B, 24: 425-7(Apr. 17, 1967).

Energy spectra of $\eta \rightarrow \pi^+\pi^-\pi^0$ and $X \rightarrow \eta\pi^+\pi^-$ decays are calculated within the framework of current algebra and the hypothesis of partial conservation of axial current (PCAC). $\eta \rightarrow 3\pi$ decay rates are obtained in the SU(3) limit. (auth)

21162 ONE-DIMENSIONAL SYSTEM OF IDENTICAL PARTICLES WITH COULOMB INTERACTION. Adamov, M. N.; Labzovskii, L. N. Vestn. Leningr. Univ., No. 16, Ser. Fiz. Khim., No. 3, 18-25(1966). (In Russian).

The one-dimensional system of fermions with Coulomb interaction is investigated. The density distribution proved to be independent of the value of the total spin in the case under consideration. For the two-particle system the exact solution of Schrödinger equation with special boundary conditions is obtained. (auth)

21163 CURRENT ALGEBRA AND RADIATIVE DECAYS OF MESONS. Fayyazuddin (Univ. of Chicago); Riazuddin. Phys. Rev. Lett., 18: 715-19(Apr. 24, 1967).

The Fubini method is applied to electromagnetic and weak processes. In particular, sum rules are obtained for radiative decays of mesons. The sum rule $(1/2\pi i)\int[a_{10}(V',t)/V'']dV = \sqrt{2}$ is derived under the assumptions of conservation of electromagnetic current, CVC, unsubtracted dispersion relations, and a commutation relation. (J.F.P.)

21164 INTERFERENCE BETWEEN K_L^0 AND K_S^0 IN THE $K_{\mu 3}$ DECAY MODE. Bott-Bodenhausen, M.; De Bouard, X.; Dekkers, D.; Felst, R.; Mermod, R.; Savin, I.; Scharff, P.; Vivargent, M.; Willitts, T. R.; Winter, K. (CERN, Geneva). Phys. Lett., Part B, 24: 438-40(Apr. 17, 1967).

The decay law of a coherent mixture of K_L^0 and K_S^0 was studied in the $K_{\mu 3}$ mode. The charge asymmetry is analyzed as a function of the regeneration phase $\arg(if_{21})$ and $\mathrm{Re}(\epsilon)$. In addition $\arg(if_{21})$ is estimated from recent measurements of K^+ and K^- absorption cross sections in carbon. (auth)

21165 PHOTOPRODUCTION OF CHARGED PIONS IN A REGGE POLE MODEL. Diu, B.; Le Bellac, M. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Lett., Part B, 24: 416-19(Apr. 17, 1967).

With a Regge pole model based on the dominance of ρ and A_2 exchange, the cross section for photoproduction of charged pions is related to that for vector meson production in π-nucleon collisions. (auth)

21166 THE IMPORTANCE OF LOOKING FOR THE ROPER RESONANCE IN PION PHOTOPRODUCTION ON DEUTERIUM. Donnachie, A. (CERN, Geneva). Phys. Lett., Part B, 24: 420-2(Apr. 17, 1967).

It is shown that pion photoproduction on neutrons is very sensitive to the Roper resonance. If found there, it must belong to an SU(3) $\{\overline{10}\}$. Combined with the Z_0^* evidence, this would drown the present quark models completely. (auth)

21167 SUPERCONVERGENT SUM RULES FOR PHOTOPRODUCTION. Razmi, M. S. K.; Ueda, Y. (Univ. of Toronto). Phys. Rev. Lett., 18: 719-22(Apr. 24, 1967).

Assuming that the Regge trajectories $\alpha_{10}(0)$, and $\alpha_{27}(0)$ are less than 0, sum rules are derived for photoproduction. Comparison with the experiment is given. (J.F.P.)

21168 NONCLASSICAL THEORY OF MAGNETIC MONOPOLES. Taylor, J. G. (Oxford Univ.). Phys. Rev. Lett., 18: 713-15(Apr. 24, 1967).

A strictly nonclassical model of magnetic monopoles which makes them far more invisible than expected is presented. At the same time this model may be used to violate CP invariance. This aspect is briefly discussed. (J.F.P.)

21169 NEUTRAL NONSTRANGE 0^- MESON PHOTOPRODUCTION AND REGGE POLES. Di Vecchia, P.; Drago, F. (CNEN, Frascati, Rome). Phys. Lett., Part B, 24: 405-8(Apr. 17, 1967).

Photoproduction of neutral nonstrange 0^- mesons is considered in the framework of Regge theory. Symmetry relations between coupling constants are widely used. The results are in good agreement with the available experimental data. (auth)

21170 CURRENT ALGEBRA AND $\eta \to 3\pi$ DECAYS. Graham, R. H.; O'Raifeartaigh, L.; Pakvasa, S. (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Nuovo Cim. (10), 48A: 830-3(Apr. 1, 1967). (NYO-3399-88).

It is pointed out that the current-algebra techniques used to study the weak decays $K \to 3\pi$ can be used to study the electromagnetic decay $\eta \to 3\pi$ if the assumption is made that the effective electromagnetic interaction $S^{\mathrm{em}}(x)$ responsible for the decays is a local operator that transforms as a tensor with respect to chiral SU(2) × SU(2). Branching ratios for $(\eta \to \pi^0\pi^0\pi^0)/(\eta \to \pi^+\pi^-\pi^0)$ and $\eta \to 2\gamma)/(\eta \to \pi^+\pi^-\pi^0)$ are obtained which are in rough qualitative agreement with experiment. (L.B.S.)

21171 THE DECAY $\eta \to \pi^0 e^+ e^-$ WITH C CONSERVATION. Smith, C. H. Llewellyn (Department of Theoretical Physics, Oxford). Nuovo Cim. (10), 48A: 834-8(Apr. 1, 1967).

The ratio $(\eta \to \pi^0 e^+ e^-)/(\eta \to \pi^0 \gamma\gamma)$ is calculated according to a Feynman diagram for a second order process in the electromagnetic interaction without C violation. The matrix element was found to be proportional to the mass of the electron, which yields the very small ratio of 2.1 (±0.5) × 10^{-8}. It is concluded that the decay $\eta \to \pi^0 e^+ e^-$ will not be observed if C is conserved. The analogous decays of the $\eta'(959)$ are briefly discussed. (L.B.S.)

21172 SUPERCONVERGENCE IN PION PHOTOPRODUCTION. Pande, L. K. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 48A: 839-42(Apr. 1, 1967). (IC-67/6).

A superconvergence relation for the pion photoproduction process is obtained, considering the relations between the amplitudes defined in the barycentric system for the t-channel ($\gamma\pi \to N\overline{N}$) and the usual invariant amplitudes. It is found that only $I = \frac{1}{2}$ states occur in the superconvergence relation. It is also found by saturating with the nucleon that $\mu_p = -\mu_n$, where μ_p and μ_n are the anomalous magnetic moments of the proton and neutron, respectively. (L.B.S.)

21173 SPIN STRUCTURE OF THE PHOTOPRODUCTION AMPLITUDE AT HIGH ENERGIES. Berkov, A. V.; Nikitin, Yu. P. (Moscow Engineering Physics Inst.). Yadern. Fiz., 5: 650-7(Mar. 1967). (In Russian).

Spin structure of the pion photoproduction amplitude at high energies is studied on the basis of the conception of moving singularities in the complex j-plane. It is shown that if the momentum transfer squared (t) vanishing a relation between the singularities with different quantum numbers arises in analogy to the nucleon-nucleon scattering. With these results and using the experimental data on the location of different pole trajectories in the complex j-plane the expressions are obtained for the spin structure of the photoproduction amplitude in different t-regions. The particle polarizations in s- and u-channels are calculated and compared with the strict results for the photoproduction at zero angle. (auth)

21174 THREE PHOTON DECAY OF NEUTRAL PIONS. Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 626-30(Mar. 1967). (In Russian).

The probabilities of the decays $\pi^0 \to 3\gamma$ and $\pi^0 \to 4\gamma$ are estimated in view of a possible C-violation in strong or electromagnetic interactions. (auth)

21175 NEUTRAL VECTOR MESON PHOTOPRODUCTION AND THE QUARK MODEL OF ELEMENTARY PARTICLES. Akhiezer, A. I.; Rekalo, M. P. (Inst. of Physics and Tech., Kharkov). Yadern. Fiz., 5: 641-3(Mar. 1967). (In Russian).

Amplitudes of the neutral vector meson photoproduction on nucleons are expressed in terms of the quark amplitudes that determine elastic hadron scattering amplitudes at high energies. The momentum transfer dependence of the photoproduction differential cross sections is predicted. (auth)

21176 ON THE PHOTOPRODUCTION OF N^* ON DEUTERONS. Schiff, D.; Tran Thanh Van, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cimento (10), 48A: 1-14(Mar. 1, 1967).

In order to study inelastic unitarity in deuteron photodisintegration, the photoproduction of N^* on a deuteron is calculated in the framework of the impulse approximation. Predictions for the ratio of N^* photoproduction on deuterons and deuteron photodisintegration cross sections are given for a proton momentum ranging from 200 to 700 MeV. It is shown that this ratio is measurable. (auth)

21177 REDUCTION OF THE ELECTROMAGNETIC VECTOR POTENTIAL TO THE IRREDUCIBLE REPRESENTATIONS OF THE INHOMOGENEOUS LORENTZ GROUP. PART II. QUANTIZATION OF THE ELECTROMAGNETIC VECTOR POTENTIAL IN AN ANGULAR MOMENTUM BASIS. Moses, H. E. (Massachusetts Inst. of Tech., Lexington). Nuovo Cimento (10), 48A: 43-57(Mar. 1, 1967).

It was previously shown how the electromagnetic vector potential could be reduced to the irreducible representation of the inhomogeneous Lorentz group corresponding to particles with zero mass and spin 1, which are identified with photons. When the photon amplitudes were replaced in a suitable fashion by annihilation and creation operators, a covariant second-quantized theory was obtained in which the Lorentz condition is satisfied identically and in which the norm of the Hilbert space is positive definite. Previous results are used to transform the photon wave functions from the linear momentum representation to the angular momentum representation. The vector potential, when second quantized, then takes the form of an expansion in terms of vector spherical harmonics in which the amplitudes are annihilation and creation operators which create and destroy photons with a specific angular momentum. This expansion is a covariant quantum analog of the expansion in multipoles of classical electromagnetic theory due to Blatt and Weisskopf and leads to the usual selection rules for atomic transitions. (auth)

21178 ETA DECAYS WITH e^+e^- AND $\mu^+\mu^-$ PAIRS. Jarlskog, C.; Pilkuhn, H. (Univ. of Lund, Sweden). Nucl. Phys., B1: 264-8 (1967).

Branching ratios for the $e^+e^-\gamma$, $\mu^+\mu^-\gamma$, $e^+e^-e^+e^-$, $e^+e^-\mu^+\mu^-$, $\mu^+\mu^-$, e^+e^- and $\pi^+\pi^-e^+e^-$ decay modes of the eta meson are calculated using ordinary quantum electrodynamics. (auth)

21179 REMARK ON PION ELECTROPRODUCTION NEAR THRESHOLD. De Tollis, B. (Univ., Rome, Istituto Nazionale di Fisica Nucleare, Rome); Nicolo, F. Nuovo Cimento (10), 48A: 381-3(Mar. 1, 1967).

An investigation is made of whether information on the meson (π) (as well as on the neutron) charge form factor may be given by simple electroproduction experiments, where only the outgoing electrons are detected, at energies near the threshold for meson (π) production. For these conditions the smallness of the cross section is balanced by the factor gained in the integration over the meson (π) directions and by a greater simplicity of the detection equipment. Also extrapolation to the threshold is independent of the models used. In fact, one may assume that the Born approximation is sufficiently adequate in this energy region. (J.F.P.)

21180 ELASTIC ed-SCATTERING AND VIOLATION OF CP-INVARIANCE. II. Dubovik, V. M.; Likhtman, E. P.; Cheshkov, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 52: 706-10(Mar. 1967). (In Russian).

The possibilities of verifying violation of CP-invariance in electromagnetic interactions of hadrons on basis of correlation effects in elastic ed-scattering are analyzed in detail. It is shown in the single-photon approximation that when T-invariance in scattering of electrons on a target polarized normal to the scattering plane is violated, the angular symmetry of recoil deuterons may reach 5% if the square of the transferred momentum $q^2 = 12F^{-2}$ and $\theta_d \approx 20°$. Prominence of the main effect is not affected by T-invariant asymmetry due to interference of one- and two-photon amplitudes because of smallness of the asymmetry (0.02% for the values of q^2 and θ_d cited above). (auth)

Weak

Refer also to abstract 21163.

21181 (UCSD-10P10-23) INTERMEDIATE VECTOR BOSON CONTRIBUTION TO THE MUON'S ANOMALOUS MAGNETIC MOMENT. Burnett, Thompson; Levine, Michael J. (California Univ., La Jolla, San Diego). Mar. 1967. Contract AT(11-1)-Gen-10. 5p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An evaluation of the weak contribution by the W meson to the meson (μ) magnetic moment, which is independent of the mass of the W, is made. (J.F.P.)

21182 PROPOSAL FOR DETERMINING THE INDUCED PSEUDOSCALAR COUPLING CONSTANT. Maksymowicz, A. (CERN, Geneva). Nuovo Cimento (10), 48A: 320-33(Mar. 21, 1967).

It has been known for some time that μ capture from the 0^+ ground state of ^{16}O to the first excited 0^- level of ^{16}N could, in principle, provide an accurate measurement of the induced pseudoscalar coupling constant in weak interactions. However, the calculation of the rate of this reaction has been hampered by the lack of an accurate wave function for the $^{16}N(0^-)$ state. It is proposed that this difficulty could be circumvented by a measurement of the rate of the β-decay from the $^{16}N(0^-)$ state back to the $^{16}O(0^+)$ ground state. The ratio of the μ-capture to β-decay rates turns out to be almost independent of the details of the nuclear wave function and thus should allow a reasonably accurate determination of the induced pseudoscalar coupling constant to be made. (auth)

21183 ISOTOPIC-SPIN DECOMPOSITION OF THE AMPLITUDES FOR $K \to 2\pi$. Cline, D. (Univ. of Wisconsin, Madison). Nuovo Cimento (10), 48A: 566-9(Mar. 21, 1967).

The possibility of determining the magnitudes and phases of the amplitudes for isotopic-spin transitions $\Delta T = I/2$, where I = 1, 3, and 5, is discussed. It is found that such a decomposition is possible provided the phase angle of the amplitude for $K^+ \to \pi^+\pi^0$ can be measured. The possibility of measurement of this phase angle using the decay modes $K^\pm \to \pi^\pm\pi^0\gamma$ is discussed. Finally, a set of amplitudes is suggested that is consistent with all experimental data and which exhibits nearly maximal CP violation for the $\Delta T = 3/2$ and $\Delta T = 5/2$ amplitudes. (L.B.S.)

21184 $K_1^0 - K_2^0$ MASS DIFFERENCE AND LOW-ENERGY π-π DYNAMICS. Rockmore, Ronald; Yao, Tsu (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev. Lett., 18: 501-3 (Mar. 27, 1967).

The $K_1^0 - K_2^0$ mass difference is investigated on the basis of a model of S-wave π-π scattering. The possibility of a di-pion resonance ($J^{PG} = O^{++}$), which was previously suggested by Truong, is questioned following a detailed examination of the so-called "dynamical correction term" in the self-energy model. (L.B.S.)

21185 S-WAVE $\pi\pi$ SCATTERING AND THE $K_1^0 - K_2^0$ MASS DIFFERENCE. Kang, Kyungsik (Brown Univ., Providence); Land, David J. Phys. Rev. Lett., 18: 503-6(Mar. 27, 1967). (NYO-2262TA-144).

The result of recent measurements of the $K_1^0 - K_2^0$ mass difference was used as a test of various solutions to s-wave $\pi\pi$ scattering which are obtained by solving the full N/D equations with various given forms of the driving force. Certain features of these solutions with regard to the evaluation of the mass difference are also pointed out. (auth)

21186 RADIATIVE CORRECTIONS TO MUON AND BETA DECAY IN THE INTERMEDIATE VECTOR BOSON THEORY. Schilcher, K. (American Univ., Beirut). Z. Phys., 201: 117-28 (1967).

The radiative corrections to muon and beta decay are examined in detail using the ξ-limiting formalism of Lee and Yang. The electron spectra for both decays are calculated. It is found that the muon lifetime discrepancy is reduced considerably if one considers, quantitatively, the effect of strong interactions on the weak vector coupling constant as determined from the neutron's lifetime. (auth)

21187 PARAMETERS η_{+-}, η_{00}, ϵ FOR $K^0 - \overline{K}^0$ DECAY. Yen, E. (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 18: 513-15(Mar. 27, 1967).

The parameter $|\eta_{00}|$ was measured to be $(4.9 \pm 0.5) \times 10^{-3}$ in two recent experiments. The implications of these experiments on some parameters involved in $K^0 - \overline{K}^0$ decay are discussed. (L.B.S.)

21188 TESTS FOR CP NONINVARIANCE WITH $|\Delta T| > 1/2$ IN THE PARTIAL RATES FOR $K^\pm \to \pi^0 + \pi^\pm$ AND $K^\pm \to \gamma + \pi^0 + \pi^\pm$. Barshay, Saul Rutgers (The State Univ., New Brunswick, N. J.). Phys. Rev. Lett., 18: 515-19(Mar. 27, 1967).

CP noninvariance with $|\Delta T| > 1/2$ and CPT invariance imply that the partial rates, $r_\pm$, for $K^\pm \to \pi^0 + \pi^\pm$, and also the partial rates, $r_\pm'$ for $K^\pm \to \gamma + \pi^0 + \pi^\pm$, will be unequal. An approximate phenomenological analysis is formulated, and suggests the possibility of $|1 - (r_-/r_+)| \cong 10^{-3}$ and $(r_-'/r_+') \cong 3$. (auth)

21189 KAON DECAY AND PION PHASE SHIFTS. Glashow, S. L. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 18: 524-6(Mar. 27, 1967).

The decays of neutral kaons are considered under the conditions that the short-lived and long-lived neutral kaons are each characterized by a unique complex mass, that the conventional formalism with TcP invariance applies, that $\Gamma(K_S \to 3\pi) \ll \Gamma(K_L \to 3\pi)$, that $K_S \to 2\pi$ satisfies an approximate $\Delta I = 1/2$ rule, and that the possibility that $\cot(\delta_0 - \delta_2) = 2\Delta m/\Gamma_S$ be excluded. Here δ_I denotes the pion phase shift at the kaon mass for $I = 0, 2$; $\Delta m = m_L - m_S$, and $\tan\phi_w = 2\Delta m/\Gamma_S \approx \tan 40°$. Under these hypotheses a relation among the four measurable quantities ϕ_w, ϕ, δ, and R, where ϕ denotes the phase of the amplitude for $K_L \to \pi^+ + \pi^-$ relative to the amplitude for $K_S \to \pi^+ + \pi^-$, δ denotes $\delta_0 - \delta_2$, and R is the branching ratio for $K_L \to 2\pi$, is obtained. In principle, the experimental evaluation of R, ϕ, and ϕ_w determines the difference of the pion phase shifts without the necessity of measuring the phase ϕ_0 of the $K_L \to 2\pi^0$ amplitude relative to the $K_S \to 2\pi^0$ amplitude. (C.E.S.)

21190 ANALYSIS OF SINGLE-PION PRODUCTION WITH INCIDENT NEUTRINOS. Salin, Ph. (Univ., Turin). Nuovo Cimento (10), 48A: 506-18(Mar. 21, 1967).

The results of photo and electroproduction obtained with the isobaric model are applied to the process $\nu + N \to \mu + N + \pi$. Numerical results are compared with the CERN neutrino bubble chamber data. Good agreement is obtained, and the results are consistent with axial form factor equal to vector form factor. (auth)

21191 INTERMEDIATE VECTOR BOSONS AS UNOBSERVABLE PARTICLES. Haller, K. (Univ. of Connecticut, Storrs); Landovitz, L. F.; Goldberg, I. Nuovo Cimento (10), 48A: 303-19 (Mar. 21, 1967).

A theory of the intermediate vector boson is proposed, in which the boson field can be described by a renormalizable Lagrangian in an indefinite-metric space. The circumstances under which an indefinite-metric space can be consistently applied are discussed. It is shown that for very massive bosons (M ~ 2500 proton masses) the indefinite metric of the space does not conflict with requirements of probability conservation. The coupling constant for the lepton-intermediate boson interaction is approximately given by $g^2 \sim 10^{-1}$ in this theory. (auth)

21192 ONE-PHOTON-EXCHANGE PROCESSES AND INELASTIC FORM FACTORS. Sandhas, Werner; Zeiler, Joachim (Freie Univ., Berlin). Z. Phys., 199: 479-94(1967).

The general form of cross section for one-photon-exchange processes is given. For unpolarized target and projectile the total cross section is determined by two characteristic functions or form factors, for each, target and projectile. For a projectile without strong, but with electromagnetic interaction one can measure the differential cross section and thereby determine both form factors for any target in the region of kinematical variables available by such scattering experiments. These kinematical regions are investigated. One can insert these measured form factors in cross section calculations for other one-photon-exchange processes. As an example it is shown that for 2-GeV-meson-W production by neutrinos on a target the kinematical region of form factors which enter the cross section calculation is covered by electron scattering up to 6 GeV. The impulse approximation is used to estimate form factors for electron-nucleus scattering in a special kinematical region. (auth)

21193 NONLEPTONIC HYPERON DECAYS. Itzykson, C.; Jacob, M. (Centre d'Etudes Nucleaires, Saclay, Gif-Sur-Yvette, France). Nuovo Cim. (10), 48A: 655-62(Apr. 1, 1967).

The algebra-of-current approach is applied to the calculation of the S and P wave nonleptonic decay amplitudes of the hyperons. It is shown that certain terms, so far neglected, can be easily introduced. This leads to a much better agreement with experiment. The approach followed presents very clearly the approximations made. (auth)

21194 COMMUTATION PROPERTIES OF THE NONLEPTONIC WEAK HAMILTONIAN AND K DECAYS. ERRATUM. Elias, D. K.; Taylor, J. C. (Department of Theoretical Physics, Oxford). Nuovo Cim. (10), 48A: 814-16(Apr. 1, 1967).

Errors in a previous paper about the application of the soft-pion method to $K \to 3\pi$ decays are corrected. The conclusions about the $\Delta T = 3/2$ contribution are changed; this improves the prediction for the $K^+ \to \pi^+\pi^+\pi^-$ spectrum. (auth)

21195 CALCULATION OF THE FORM FACTORS IN K_{l3} DECAY. Bartl, A.; Korthals Altes, C. P. (International Atomic

Energy Agency, Trieste, Italy). Nuovo Cim. (10), 47A: 721-9 (Feb. 21, 1967).

An evaluation of the form factors of the K_{l3} decay is performed by means of the SU_3 algebra of currents and the method of Fubini et al. The SU_3-breaking corrections are calculated with help of dispersion technique, taking into account the lowest-lying intermediate states. (auth)

21196 ON CURRENT ALGEBRA AND CVC IN PION BETA DECAY. Bell, J. S. (CERN, Geneva); Berman, S. M. Nuovo Cim. (10), 47A: 807-10(Feb. 21, 1967).

It is observed that in pion beta decay the coupling constants are dictated by current algebra and PDDAC, independently of CVC. (auth)

21197 SEARCH FOR THE DECAY OF PHOTOPRODUCED φ MESONS INTO $\mu^+ + \mu^-$. Chase, R. C.; Rothwell, P.; Weinstein, Roy (Northwestern Univ., Boston). Phys. Rev. Lett., 18: 710-12 (Apr. 24, 1967).

A result of an experiment for studying the feasibility of extending previous work on photoproduction of meson (μ) pairs to higher values of the invariant $\mu\mu$ mass is considered. Upper limits are placed on the yield and cross section ratios for meson (μ) decay of the mesons (ρ) and (φ). (J.F.P.)

21198 DEFINITION OF THE FERMION CURRENT DENSITY IN VECTOR COUPLING THEORIES. Sokolov, V. V.; Khriplovich, I. B. Yadern. Fiz., 5: 644-9(Mar. 1967). (In Russian).

A correct definition is given of the fermion current density in theories with a nonabelian gauge group. It seems that this definition should be used even if the gauge invariance is violated. With its help relations are obtained between the spectral functions in a model of the leptonic weak interactions with an intermediate boson. (auth)

21199 SOME REMARKS ON PARITY VIOLATION. Kastrup, H. A. (Univ., Bern). Nuovo Cimento (10), 48A: 271-4(Mar. 1, 1967).

Invariance under C(15, ++) is clarified, and the noninvariance of the weak Hamiltonian under the transformation R is discussed. It is assumed that the weak interactions are mediated by vector bosons. As an illustration a β^- decay ($n \rightarrow p + e^- + \bar{\nu}_e$) with an allowed Fermi transition is considered. Also a possible method for finding some traces of the intermediate boson is pointed out. (J.F.P.)

21200 THE PROCESS $\gamma + \gamma \rightarrow \nu + \bar{\nu}$. Levine, M. J. (Univ. of California, San Diego, La Jolla). Contract AT(11-1)-Gen-10. Nuovo Cimento (10), 48A: 67-71(Mar. 1, 1967). (UCSD-10P10-8).

The cross section for $\gamma + \gamma \rightarrow \nu + \bar{\nu}$ is calculated, in the limit $s \ll M_W^2$, for a weak interaction mediated by a vector meson, W, having a minimal electromagnetic interaction and an arbitrary anomalous magnetic moment. It is found to be cut-off-independent and considerably smaller than estimated. (auth)

21201 MAGNETIC MOMENTS OF HYPERONS. Combe, J.; Gibson, W. M.; Hoffmann, L.; Vanderhaeghe, G. (CERN, Geneva). Z. Naturforsch., 21a: 1757-60(1966). (In German).

An attempt is made to summarize the present status of knowledge about the magnetic moment of hyperons, describing the method of measurements and reviewing the results obtained in various high energy laboratories. (auth)

Strong (General)

Refer also to abstract 21486.

21202 (JINR-P1-3164) ODIN SPOSOB IDENTIFIKATSII REZONANSOV. (One Method of Resonance Identification). Kopylov, G. I.; Khvastunov, M. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 14p. (In Russian). Dep. mn.

It is suggested that the resonances in two-particle reactions can be identified not by the effective mass of their decay products, but by the Lorentz factor. (auth)

21203 MULTIPLE MESON PRODUCTION AND SOME PROPERTIES OF LOQUIAN DISTRIBUTIONS. von Lindern, L. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cimento (10), 48A: 289-302(Mar. 21, 1967).

Some properties of angular distributions of jets of mesons produced in high-energy interactions are discussed in terms of the variable $\lambda = \log \gamma_s \operatorname{tg} \Theta_L$ (γ_s = Lorentz factor of the c.m. system, Θ_L = emission angle in the laboratory system). Such distributions are called loquian distributions, because for a given distribution in the c.m. system, they are approximately independent of the primary energy. λ = logarithmic quasi invariant angle. Loquian distributions for different c.m. system amplitudes are given and an analysis is discussed in terms of the moments of the loquian distributions. A fireball loquian distribution is approximately decomposed into one centre c.m. system amplitudes. (auth)

21204 TRANSVERSE-MOMENTUM DISTRIBUTION OF SECONDARIES FROM HIGH-ENERGY NUCLEAR INTERACTIONS AND INTERPRETATION BY MEANS OF A STATISTICAL MODEL. Imaeda, K. (Dublin Inst. for Advanced Studies). Nuovo Cimento (10), 48A: 482-505(Mar. 21, 1967).

An analysis of the experimental transverse momentum p_t of secondary particles produced in high-energy nuclear interactions in the accelerator energy region is carried out. The average value of p_t for each kind of particle is almost constant for primary energy from 6 GeV up to cosmic-ray energy. Several theoretical p_t distributions are fitted to the experimental p_t distribution. The experimental p_t distributions of π-mesons, K-mesons, nucleons, Λ and Σ were well fitted by the theoretical p_t distributions derived from the momentum distributions of Planck for mesons and of Fermi for baryons. The characteristic parameter kT involved in the theoretical p_t distribution is nearly constant for all kinds of particles and is ~0.125 GeV. It is shown that the p_t distribution of protons from large-angle p-p elastic scattering and that of secondaries from inelastic interactions are similar in shape and are governed by the same statistical law. The relations between the above two p_t distributions are discussed. On the basis of statistical theory, a derivation of the theoretical p_t distribution is given. (auth)

21205 A NOTE ON SCHWINGER TERMS. Choudhury, S. Rai (Princeton Univ., N. J.). Nuovo Cimento (10), 48A: 560-2(Mar. 21, 1967).

A general method was presented by Weinberg (Phys. Rev. Lett., 17: 616, (1966)) for the calculation of low-energy pionic scattering parameters. The method employs basically the equal-time commutation relations and the PCAC relation, with no consideration given to the possible existence of Schwinger terms. It is shown that if the σ-model is used consistently, it follows almost trivially that the Schwinger terms do not affect the final result obtained by Weinberg. (L.B.S.)

21206 CURRENT ALGEBRAS IN A PERTURBATION-THEORETIC MODEL. Hamprecht, B. (Cambridge Univ., Eng.). Nuovo Cim. (10), 47A: 770-85(Feb. 21, 1967).

The model of Johnson and Low is extended to all orders in perturbation theory. It is shown that additional terms in the commutator of two currents can only arise from integrals connected with divergent Feynman diagrams. Furthermore, the appearance of these additional terms depends on the details of the cut-off prescription. Thus it is concluded that the model is compatible with certain additional terms but cannot be said to predict their presence because of our lack of understanding of the details of the renormalization procedure. (auth)

21207 CURRENT COMMUTATION RELATIONS AND PIONIC REACTIONS. Jacob, M.; Mahoux, G. (Centre d'Etudes Nucleaires, Saclay, France). Nuovo Cim. (10), 47A: 742-58(Feb. 21, 1967).

The consequences imposed by the particular form of the equal-time commutators of current densities, which follows from the algebra of current operators, can be studied in two ways. It is possible to obtain first the consequences of the support conditions imposed on the equal-time commutator of two field theory operators, and then, to obtain the further relations imposed by the particular structure which appears in the algebraic relations. This is the approach followed here. In so doing, particular attention is paid to nearby singularities and the only assumption made is that, once the contribution of these terms has been obtained, the remainder is a slowly varying function. The other, and currently used, approach consists in obtaining direct relations, which already include the strong constraints imposed by the algebraic relations, notwithstanding the more general and weaker constraints imposed on the Fourier transform of an equal-time commutator of two field operators. These more general and weaker constraints alone yield, in particular, the consistency relations imposed by the PDDAC (pion dominance of the divergence of the axial current) hypothesis. Several relations for pionic reactions are presented. (auth)

21208 ASYMPTOTIC SUMMATION OF LADDER DIAGRAMS AT HIGH ENERGIES. Vasev, V. G.; Ginzburg, I. F. Yadern. Fiz., 5: 669-84(Mar. 1967). (In Russian).

A system of equations of the Bethe–Salpeter type is investigated by means of diagrams summation with $\pi\pi$- and πn-interactions taken into account. The relations between the $\pi\pi$-, πn-, nn and $n\bar{n}$-scattering amplitudes are established. A system of ordinary differential equations satisfied by these amplitudes is obtained (in the main logarithmic approximation of the perturbation theory). At high energies the asymptotic behavior of the amplitude is deter-

mined by all the admissible (two particle) intermediate states in cross channel and not by a single one. The difference between the total propagators and the unperturbed Green functions is taken into account. (auth)

21209 SEARCH FOR QUARKS. de Swart, J. J. (Univ. of Pittsburgh). Phys. Rev. Lett., 18: 618-19(Apr. 10, 1967).

The quark is probably unstable with respect to strong interactions. It is possible that the stable particle with nonintegral charge has a charge $|Q|>2/3$. (auth)

21210 ADLER–WEISBERGER RELATION AND DISPERSION SUM RULES IN THE THEORY OF STRONG INTERACTIONS. Bogolubov, N. N.; Matveev, V. A.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Nuovo Cimento (10), 48A: 132-9(Mar. 1, 1967).

On the basis of unsubtracted dispersion relations for the quantity related to the divergences of the local axial-vector currents, the well-known Adler–Weisberger relations were obtained. Also the additivity principle was used in the quark model for forward scattering amplitudes near threshold. (auth)

21211 RELATIONS BETWEEN TOTAL CROSS-SECTIONS AT HIGH ENERGY. Yabuki, H. (Tokyo Univ.). Nuovo Cimento (10), 48A: 229-32(Mar. 1, 1967).

It is shown that the quark model and the algebraic method in the framework of the Regge pole theory for relations between total cross sections at high energies are equivalent in the sense that their parameterizations of the total cross sections are equivalent to each other. It is noted that this equivalence holds only at some fixed energy. (J.F.P.)

Strong (Baryon No. = 0)

Refer also to abstracts 21161, 21163, 21234, 21251, and 21285.

21212 (JINR-P2-3182) UNITARNO-SIMMETRICHNAYA STATISTICHESKAYA TEORIYA MNOZHESTVNENNOGO ROZHDENIYA CHASTITS. (Unitary–Symmetrical Statistical Model of Multiple Particle Production). Barashenkov, V. S.; Zinov'ev, G. M.; Mal'tsev, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 20p. (In Russian). Dep. mn.

A statistical model is suggested in which particles are considered as the terms of SU(3)-multiplets and transitions are possible only between states corresponding to the identical irreducible representations of the group SU(3). The $\bar{p}$-p and $\bar{p}$-n annihilation at rest processes and inelastic $\pi^{\pm}$p interactions in the energy range T > 1 GeV are considered in detail. Introducing the splitting of the effective coupling constant which is due to the difference between the interactions of the K meson and other particles one obtains results close to experimental ones. A noticeable disagreement with experiment occurs only for channels with a small number of particles where a more detailed approach is needed. (auth)

21213 THE REACTION $p\bar{p} \rightarrow \Lambda^*_{33}\bar{\Lambda}^*_{33}$ AT 5.7 GEV/c. Alles-Borelli, V.; French, B ; Frisk, A.; Michejda, L. (CERN, Geneva). Nuovo Cimento (10), 48A: 360-75(Mar. 21, 1967).

A study of 3638 events of the reaction $p\bar{p} \rightarrow p\bar{p}\pi^+\pi^-$ at 5.7 GeV/c in the 81 cm Saclay hydrogen bubble chamber is reported. The measurements were made with the CERN HPD system. The cross section for the channel $p\bar{p} \rightarrow p\bar{p}\pi^+\pi^-$ was found to be (3.31 ± 0.16) mb. Abundant associated production of $\Lambda^*_{33}(1238)\bar{\Lambda}^*_{33}(1238)$ was observed; the cross-section for the process $p\bar{p} \rightarrow \Lambda^*_{33}\bar{\Lambda}^*_{33}$ is (2.08 ± 0.14) mb, which corresponds to (63 ± 3)% of the total cross section for the studied channel. The production mechanism of $\Lambda^*_{33}\bar{\Lambda}^*_{33}$ was investigated and the experimental results compared with various predictions of the one-pion exchange model modified to take into account absorption in the initial and final states (absorption model). The slope of the differential cross section is rather well reproduced by this mode, the experimental value is however exceeded by a factor of about three. The decay parameters of the joint decay distribution were measured and found to be in reasonable agreement with the theoretical predictions. A small correlation between the decay angles of the Λ^*_{33} and $\bar{\Lambda}^*_{33}$ respectively of 0.10 ± 0.04 was found and is in agreement with the prediction of 0.05 from the absorption model. (auth)

21214 PRECISE RELATIONS BETWEEN THE SPECTRA OF VECTOR AND AXIAL-VECTOR MESONS. Weinberg, Steven (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 507-9 (Mar. 27, 1967).

Two sum rules are derived, relating moments of the spectral functions of the vector and axial-vector currents. If it is assumed that the ρ and A1 mesons dominate these moments, then their masses must be in the ratio $m_{A1}/m_\rho = \sqrt{2}$, in very good agreement with experiment. (auth)

21215 W-MESON PRODUCTION IN PROTON–ANTIPROTON ANNIHILATIONS. Lapidus, I. R. (Stevens Inst. of Tech., Hoboken, N. J.). Nuovo Cimento (10), 48A: 334-43(Mar. 21, 1967).

The cross sections for W-meson production with a single pion or kaon in proton-antiproton annihilations were calculated using a model in which single-meson intermediate states dominate. Considerations of unitary symmetry and ω-φ mixing, previously discussed in connection with annihilation into strongly interacting mesons only as well as W-meson decays, were combined in the calculations. It is found that the predicted cross sections are large enough to suggest that W mesons may be observable in annihilation reactions at high energies. (auth)

21216 BOOTSTRAP SOLUTIONS IN A VECTOR-MESON MODEL. Contogouris, A. P.; Diu, B.; Pusterla, M. (CERN, Geneva). Nuovo Cimento (10), 48A: 412-29(Mar. 21, 1967).

In a model with a left-hand discontinuity defined by the exchange of a vector meson with a sharp cut-off elastic-unitary bootstrap solutions are derived for a number of values of the vector meson mass, by solving the Fredholm integral equation obtained from the usual N/D decomposition. The corresponding self-consistent pseudoscalar-vector couplings are found to be larger than the experimental ones. In all cases the iteration expansion (in powers of the coupling) is shown to converge. It is then proved that the denominator functions are Herglotz; and that all the self-consistent solutions obtained correspond to ghost-free amplitudes. A sum rule derived on grounds of the asymptotic and threshold properties is found to be fulfilled. Finally, Levinson's theorem is shown to be satisfied. (auth)

21217 PION RANGE-ENERGY CURVE IN THE REGION USEFUL FOR MESONIC DECAY OF HYPERNUCLEI. Fok, C.; Barkas, W. H. (Univ. of California, Riverside). Nuovo Cimento (10), 48A: 587-8(Mar. 21, 1967). (UCR-P-107-38).

A possible error in the shape of the emulsion range-energy curve was suggested, based on a disagreement found between the values obtained from different decay modes of $^4H_\Lambda$ in a recent study of hypernuclear binding energies. A self-consistent procedure was used to measure the pion range at 10 to 50 MeV in 10-MeV intervals. No significant deviation was established from the range-energy data in general use. (L.B.S.)

21218 ALGEBRA OF CURRENTS AND $\rho^0 \rightarrow \pi^+\pi^-\gamma$ DECAY MODE. Srivastava, P. P. (Syracuse Univ., N. Y.). Nuovo Cimento (10), 48A: 563-5(Mar. 21, 1967). (NYO-3399-65).

The algebra-of-currents commutation relations and the PCAC hypothesis are used to calculate the decay $\rho^0 \rightarrow \pi^+\pi^-\gamma$ and relate it to the decay mode $\rho^0 \rightarrow 1^+1^-$. (L.B.S.)

21219 MESON COUPLING CONSTANTS IN A QUARK MODEL. Cook, P. A. (Univ. of Manchester, Eng.). Nuovo Cimento (10), 48A: 570-2(Mar. 21, 1967).

A model for strong interactions that involve P-wave pseudoscalar mesons is considered in which hadrons are regarded as being composed of quarks according to the usual assigments of the fractionally-charged quark model, and the basic interaction considered is a quark-quark-meson coupling. Coupling constants and decay widths are calculated for $\rho \rightarrow \pi\pi$, $\rho \rightarrow K\bar{K}$, $\varphi \rightarrow K\bar{K}$, $K^* \rightarrow K\pi$, and $\omega \rightarrow \rho\pi$. (L.B.S.)

21220 MESONS AS REGGE DIPOLES. Sawada, T. (Tokyo Univ. of Education). Nuovo Cimento (10), 48A: 534-40(Mar. 21, 1967).

Equations are given for the contribution of the Regge pole of the t-channel at $l = \alpha(t)$ and of the Regge dipoles at $l = \alpha(t)$ to the high-energy behavior of the scattering amplitude A(s,t). The restriction on the Regge parameters of the first- and second-sheet amplitudes is derived using the unitarity condition and by fixing $|S|$ large where the contributions from the Regge poles dominate. It is found that the leading trajectories of the first- and second sheet amplitudes must have dipole structure and pass through unity at t = 0. Properties of the lower trajectories are considered, and the additional assumption is made that the Regge parameter of the first- and second-sheet amplitudes are the same. Finally, the implication of the dipole structure of the Regge trajectory for ρ is examined. (L.B.S.)

21221 RELATION BETWEEN BARE AND PHYSICAL MASS OF VECTOR BOSONS IN A TWO-DIMENSIONAL FIELD THEORY. Haberler, P. L. F. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 47A: 929-31(Feb. 21, 1967). (IC-66/114).

The validity of Johnson's proof (Nucl. Phys., 25, 435, (1961)) concerning the relation between the physical and bare mass of vector mesons is re-examined in the framework of a two-dimensional model, which is an extension of the Schwinger–Thirring–Wess models. The discussion is carried out in a one space—one time dimensional theory of vector mesons φ_μ, with bare

mass μ_0 in interaction with a fermion field, with bare mass m_0. The vector meson is coupled to a conserved gauge-invariant current. The limiting case as μ_0 tends to zero is compared with electrodynamics. Several conclusions are reached, and it is found that the theory exhibits some physically meaningful features which stimulate further investigation. (L.B.S.)

21222 PROTON–ANTIPROTON ANNIHILATION INTO TWO PSEUDOSCALAR MESONS IN BROKEN SU_{6W}. Gupta, S. Nanda (Delhi Univ. National Physical Lab., New Delhi). Nuovo Cim. (10), 47A: 915-18(Feb. 21, 1967).

Proton–antiproton annihilations into $\pi^+\pi^-$, K^+K^-, and $K^0\bar{K}^0$ channels are studied within the framework of broken SU_{6W} to examine whether the broken symmetry can give any improvement over earlier results obtained in various symmetry schemes. Although the symmetry breaking eliminates the pion channel, the same bad prediction for $\sigma(K^+K^-):\sigma(K^0\bar{K}^0) = 4:1$ of the exact symmetry was obtained. It is found, however, that the symmetry breaking eliminates the bad ratio between $\pi\pi$ and $K\bar{K}$ production. (L.B.S.)

21223 CHIRALITY COMMUTATOR AND VECTOR MESONS. Frampton, P. H. (Oxford Univ.). Nuovo Cim. (10), 48A: 703-8 (Apr. 1, 1967).

Two independent sum rules are derived from the matrix element of the chirality commutator between ρ^+ states. One of them is the same as a super-convergent dispersion relation found by De Alfaro et al. Saturating the sum rules with π, ω, A_1 and A_2 leads to a prediction of angular correlation in A_1 decay. (auth)

21224 EXTRAPOLATION PROBLEM IN CURRENT-ALGEBRA CALCULATIONS OF THE $\pi-\pi$ SCATTERING LENGTHS. Sucher, Joseph; Woo, Ching-hung (Univ. of Maryland, College Park). Contract AFOSR 500-66. Phys. Rev. Lett., 18: 723-6(Apr. 24, 1967).

The care needed in the interpretation of PCAC smoothness conditions are commented on in connection with an apparent contradiction with the use of a power series representation in current algebra calculation of the $\pi-\pi$ scattering lengths. Also the ambiguities that beset a determination of the $\pi-\pi$ scattering lengths are re-emphasized with specific examples. (J.F.P.)

21225 LOW-ENERGY K_2^0-PROTON INTERACTIONS. Chand, Ramesh (Wayne State Univ., Detroit). Nuovo Cim. (10), 47A: 811-16(Feb. 21, 1967).

The low-energy data on K_2^0-proton collisions are analyzed in terms of the I = 0, s-wave $\bar{K}N$ scattering length α_0. It is found that even though K_2^0p reactions provide a good means of distinguishing between the various $\bar{K}N$ scattering parameters solutions, they cannot be used to determine the correct value of α_0. (auth)

21226 SELF-CONSISTENT CALCULATION OF $\pi-\pi$ SCATTERING LENGTHS, MASS, AND WIDTH OF THE σ-MESON. Sewerynski, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., Part B, 24: 423-5(Apr. 17, 1967).

$\pi-\pi$ scattering lengths, mass and width of the σ-meson are obtained by a self-consistent calculation using unsubtracted dispersion relations and the method of Balazs. (auth)

21227 OBSERVATION OF THE (e^+e^-)-DECAY MODES OF NEUTRAL VECTOR MESONS. Khachaturyan, M. N.; Azimov, M. A.; Baldin, A. M.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 24B: 349-52(Apr. 3, 1967).

The (e^+e^-) decay rates of vector mesons were measured using spark chambers and Cherenkov gamma spectrometers. (auth)

21228 NEW SET OF $\pi-\pi$ PHASE SHIFTS. Walker, W. D.; Carroll, J.; Garfinkel, A.; Oh, B. Y. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev. Lett., 18: 630-3 (Apr. 10, 1967). (COO-881-98).

A set of s-wave phase shifts in the region of the ρ is deduced from a compilation of data on $\pi-\pi$ scattering. The results indicate slowly varying I = 2 and I = 0 s-wave phase shifts. The preferred set indicates that the I = 0 phase shift might go through 90° in the neighborhood of 850–950 MeV. (auth)

21229 DISPERSION RELATIONS FOR COMPLEX VALUES OF t FROM AXIOMATIC FIELD THEORY. Sommer, G. (CERN, Geneva). Nuovo Cimento (10), 48A: 92-106(Mar. 1, 1967).

It is proved from axiomatic field theory that for any elastic scattering process for which fixed-t dispersion relations in s are valid the scattering amplitude is simultaneously analytic in s and t in

$$\left\{s,t \middle| \begin{array}{l} s \in \text{cut plane with cuts } s_{thr} \le s \le \infty,\ u_{thr} \le u \le \infty \\ |t| < R_t \end{array}\right\}$$

The value of R_t is found by a very simple recipe: it is just the maximum (measured in the t plane) of the right extremity of the small Lehmann ellipse. For example, one immediately finds $R_t = 4\mu^2$ for $\pi\pi$ and πK scattering and $R_t \simeq 1.83\mu^2$ for πN scattering. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 21212.

21230 COMPARISON OF THE $K^{\pm}p$ ELASTIC SCATTERING WITH THE OPTICAL MODELS. Fridman, A.; Michalon, A. (Centre de Recherches Nucleaires, Strasbourg). Nuovo Cimento (10), 48A: 344-53(Mar. 21, 1967).

The comparison of the $K^{\pm}p$ elastic scattering with the optical models is carried out by using a phenomenological radius of the target nucleon which is calculated from the elastic and total cross sections at the same momentum. Good agreement is obtained using phase shifts which have in the elastic differential cross section a term analogous to a propagator factor. From the calculated variation of the target radius with incident momentum these models predict a small shrinking of the K^+p diffraction peak but a greater width for the K^+p peak than K^-p peak. (auth)

21231 UNIVERSALITY AND THE EXISTENCE OF QUARKS. Maheshwari, A. N.; Schonberg, E. (Univ. of Chicago). Nuovo Cimento (10), 48A: 354-9(Mar. 21, 1967). (COO-264-327; EFINS-66-63).

The cross sections for production of light and heavy quarks in π^+-p scattering are calculated using the universality and SU_4 symmetry of strong interactions. The results are several orders of magnitude larger than the upper limits set by experiments, which suggest that either quarks do not exist at all, or some very large potential barrier strongly suppresses their introduction in p-p and p-nucleus interactions. (auth)

21232 OBSERVATION OF THE REACTION $K^+p \to pp\bar{\Lambda}$. Bassompierre, G. (CERN, Geneva); Goldschmidt–Clermont, Y.; Grant, A.; (and others). Nuovo Cimento (10), 48A: 589-91(Mar. 21, 1967).

Fourteen events of the type $K^+ + p \to pp\bar{\Sigma}^0$ and two of the type $K^+ + p \to pp\bar{\Lambda}$ were found from a sample of 10,600 2-prong V^0 events by systematically studying bubble-chamber pictures obtained from separated K^+ beams at 5 GeV/c. The following cross sections were found: $\sigma(K^+ + p \to pp\bar{\Lambda}) = (3.2 \pm 1.0)\ \mu b$ and $\sigma(K^+ + p \to pp\bar{\Sigma}^0) = (0.6 \pm 0.6)\ \mu b$. The production characteristics of these reactions were also studied. (L.B.S.)

21233 $U_{4,4}$ AND SUPERCONVERGENT SUM RULES FOR $\pi N \to \pi N^*$ SCATTERING. Jones, H. F.; Scadron, M. D. (Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 48A: 545-9 (Mar. 21, 1967).

A technique similar to that proposed by De Alfaro et al., in which strong-interaction sum rules were based on convergence properties of fixed momentum transfer dispersion relations, is applied to the problem of $\pi N \to \pi N^*$. The eight independent sum rules are saturated with the lowest-lying N(939) and $N^*(1236)$ intermediate states. It is found that the three basic sum rules are consistent in the equal-mass limit ($m_{N^*} \to m_N$) and give the exact U(6,6) coupling constant predictions. The appropriate mass shell U(6,6) results appear to follow simply from isospin invariance and the saturation of superconvergent sum rules by the lowest-lying SU(6) multiplet. (L.B.S.)

21234 DOUBLE RESONANCE PRODUCTION AT HIGH ENERGIES: CORRELATIONS BETWEEN THE DECAY DISTRIBUTIONS OF RESONANCES IN THE QUARK MODEL. Bialas, A. (Jagellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow); Gula, A.; Muryn, M. Phys. Lett., Part B, 24: 428-31(Apr. 17, 1967).

The correlations between the decay distributions of resonances produced in the processes $\pi p \to \rho N^*$ $Kp \to K^*N^*$ and $p\bar{p} \to N^*\bar{N}^*$ are investigated in the framework of the quark model. It is found that the discussed predictions of the quark model are in good agreement with the existing data, and they are similar to the result of the absorption model calculations. (auth)

21235 CURRENT ALGEBRA AND UNPHYSICAL RANGE IN DISPERSION RELATIONS. Minguzzi, A. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna); Velo, G. Nuovo Cimento (10), 48A: 531-3(Mar. 21, 1967).

A correction is made to sum rules derived from current algebra and generalized PCAC and from K–N dispersion relations, in which the appearance of an unphysical range is considered. (L.B.S.)

21236 DEVIATION FROM THE STATIC MODEL FOR MESON–BARYON SCATTERING. DerSarkissian, M. (Temple Univ., Philadelphia). Nuovo Cim. (10), 47A: 906-14(Feb. 21, 1967).

In order to test the deviation from the S-matrix theory version of the static model for a specific example, the exchange of the Σ-particle in the reaction $\pi + \Lambda \to \pi + \Lambda$ for the states I = 1 and $J = \frac{1}{2}, \frac{3}{2}$ is considered. The Σ-pole when projected into the above states produces a short cut which is then approximated by a pseudopole. The residue of the pseudopole has a simple numerical

value only in the static limit. It is first shown that the static-limit value does not depend on the $\Sigma - \Lambda$ mass difference; this is a feature one would expect for any example of meson–baryon scattering. It is then shown explicitly how the residue of the pseudopole deviates from its static-limit for $m_\pi = 1$ and $M_\Sigma - M_\Lambda = \frac{1}{2}$. For the example considered the residue of the pseudopole increases for the state $J = \frac{1}{2}^{(+)}$ and decreases for the state $J = \frac{3}{2}^{(+)}$; the deviation from the static-limit values is quite substantial. Hence the static model over-estimates the Σ-exchange force in the $J = \frac{3}{2}^{(+)}$ state of the $\pi\Lambda$ system and underestimates the force in the $J = \frac{1}{2}^{(+)}$ state. There seems to be no simple rule to determine a priori which situation will prevail for a given meson–baryon system. (auth)

21237 THE FERMI–YANG MODEL FOR THE PION AND THE HIGH-ENERGY BEHAVIOR OF THE π–N SCATTERING. Futami, Y.; Sawada, T. (Tokyo Univ. of Education). Nuovo Cim. (10), 48A: 843-4(Apr. 1, 1967).

It is pointed out that the composite model of the pion due to Fermi and Yang yields results for the total cross section of pion–nucleon scattering in the high-energy limit which are consistent with experiments. (L.B.S.)

21238 SUGGESTIVE FEATURES IN πN CHARGE–EXCHANGE POLARIZATION ASSOCIATED WITH REGGE CUTS. Chiu, C. B.; Finkelstein, J. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nuovo Cim. (10), 48A: 820-9(Apr. 1, 1967). (UCRL-17318).

Various possibilities that have been proposed within the Regge pole model to explain the observed π^-p charge exchange polarization are examined. The dependence of this polarization upon both energy and momentum transfer is examined in detail. A general expression is first derived for the polarization due to the interference between the δ pole and the δ–p cut, neglecting contributions of higher order cuts. The expected high-energy behavior of the polarization is then discussed in some detail. Finally, two sample fits to the existing charge–exchange polarization data are presented. (L.B.S.)

21239 LOW-ENERGY s- AND p-WAVE KN SCATTERING. Cho, K. S. (Drexel Inst. of Tech., Philadelphia). Nuovo Cim. (10), 47A: 707-20(Feb. 21, 1967).

The double dispersion relation together with the Balázs approximation method is applied to KN scattering. The coupling constants of various exchange particles are adjusted to reproduce the experimental scattering lengths and it is found that their values are compatible with those predicted by SU_3 symmetry. It is also found that the contributions to the potential for the I = 0 state from $Y_1^*(1385)$, $Y_0^*(1520)$ and the ρ-meson exchange are repulsive, while that from the χ-meson exchange, which represents the average effect of ω- and φ-meson exchange, is attractive; for the I = 1 state the contributions from the ρ, χ and $Y_0^*(1520)$ exchanges are attractive, while those from the hyperons are repulsive. The calculated phase shifts of the $s_{1/2}$, $p_{1/2}$ and $p_{3/2}$ states agree quite well with experiment. (auth)

21240 A NEW EVALUATION OF THE ADLER–WEISBERGER SUM RULE. Hoehler, G.; Strauss, R. (Technische Hochschule, Karlsruhe, Ger.). Phys. Lett., Part B, 24: 409-10(Apr. 17, 1967).

The evaluation of the Adler–Weisberger sum rule will be discussed using the results of an analysis of πN charge–exchange scattering. (auth)

21241 A REGGE POLE ANALYSIS OF ρ^- DECAY ANGULAR DISTRIBUTION AND PRODUCTION IN $\pi^- + p \rightarrow \rho^- + p$. Paciello, M. L.; Pugliese, A. (Univ., Rome). Phys. Lett., Part B, 24: 431-4(Apr. 17, 1967).

A Regge pole model is applied to ρ^- production and decay including π and ω trajectory contributions. Helicity residues are obtained by fitting the ρ^- decay matrix elements at 8 GeV/c. Satisfactory results for the differential cross section and decay matrix are achieved. (auth)

21242 LOW ENERGY PION–NUCLEON SCATTERING. Banerjee, H.; Dutta-Roy, B. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Lett., Part B, 24: 413-16(Apr. 17, 1967).

On the basis of dynamical assumptions implicit in recent derivations of the s-wave π-N scattering lengths sum rules for the π-N coupling constant and the subtraction constant in the π-N forward dispersion relations are obtained. The estimates for these quantities are in excellent agreement with their recent experimental determination. (auth)

21243 TWO-REGGEON BRANCH POINTS AND DOUBLE CHARGE EXCHANGE. Phillips, R. J. N. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 24B: 342 (Apr. 3, 1967).

It is pointed out that two-Reggeon branch points destroy some superconvergence relations, and that in double-charge exchange processes they probably dominate over Regge poles. (auth)

21244 EXACT MASS-FORMULA FOR BARYONS. Zaikov, R. G. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 997-9(1966).

The exact mass formula for baryons is found using the known properties of baryons and superparity q which is defined as $q = (-1)^{I-\frac{1}{2}Y_B}$. Values of the masses of the isomultiplets $\frac{5}{2}^+$, $\frac{1}{2}^+$, and $\frac{1}{2}^-$ are given. (J.F.P.)

21245 SPIN STRUCTURE OF AMPLITUDES OF THE ARBITRARY SPIN MESON PRODUCTION IN πN COLLISIONS. Karnakov, B. M. (Moscow Engineering Physics Inst.). Yadern. Fiz., 5: 658-62(Mar. 1967). (In Russian).

For the production of arbitrary spin-parity mesons in πN-collisions the explicit choice of amplitudes is pointed out so that the invariant functions are free of kinematical singularities. (auth)

21246 DYNAMICS OF POSITIVE-PARITY BARYON EXCITED STATES. Golowich, E. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev. Lett., 18: 633-6(Apr. 10, 1967).

The dynamics of positive–parity excited baryon states with a bootstrap model involving high-spin baryons is studied. A spectrum of broken SU(2) ⊗ O(3) multiplets is implied by the calculation. (auth)

21247 NEW SUM RULES AND SINGULARITIES IN THE COMPLEX J PLANE. Igi, Keiji; Matsuda, Satoshi (Tokyo Univ.). Phys. Rev. Lett., 18: 625-7(Apr. 10, 1967).

Exact sum rules to investigate singularities in the complex angular momentum plane are obtained. (auth)

21248 REGGE RECURRENCES AND π p CHARGE-EXCHANGE POLARIZATION AT HIGH ENERGIES. Altarelli, G.; Borgese, A.; Buccella, F.; Colocci, M. (Univ., Florence). Nuovo Cimento (10), 48A: 245-50(Mar. 1, 1967).

The implications of the model, in which the known Regge recurrences are extrapolated to higher energies for the investigation of the π + p elastic scattering at high momentum transfers, are considered for the polarization of the recoil neutron in the charge exchange reaction $\pi^- + p \rightarrow \pi^0 + n$ at energies above 6 GeV/c. It is shown that polarization effects, in fair agreement with experiment, can also be obtained with a resonant background model, without having to introduce the ρ^- trajectory, Mandelstam cuts, or other non-Regge effects. (J.F.P.)

21249 PHYSICAL OPERATORS AND η-$\mathcal{N}$, ρ-$\mathcal{N}$, ω-$\mathcal{N}$ COUPLING CONSTANT CALCULATION. Andriambololona, Raoelina (Faculte des Sciences, Marseille). Nuovo Cimento (10), 48A: 197-223(Mar. 1, 1967).

A method for the research of eigenoperators of a given Hamiltonian is presented. It is applied to the Fermi-type interaction; the expressions of the "physical" operators of fermion, antifermion and bound states are given and it is ascertained that they verify the free-field commutation relations in the "extended pair approximation." The relation between Fermi and Yukawa theories is obtained by means of "physical" operators, and the expression of the effective Yukawa coupling constant is given. A model is given and the bound states obtained as π, η, ρ and ω mesons are interpreted. The η-N, ρ-N, ω-N coupling constants are calculated from the π-N coupling constant. The rationalized coupling constants are respectively equal to $\overline{g}^2_{\eta\text{-}N} = 13.63$, $\overline{g}^2_{\rho\text{-}N} = 12.64$, $\overline{g}^2_{\omega\text{-}N} = 12.45$. For η-N, results in good agreement with those of Yamazaki, Dhar and Katayama are found. The values of ρ-N and ω-N coupling constants verify very well a formula derived by Miyazawa and Sugawara from dispersion relations. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 21234 and 21462.

21250 (UCSD–10P10–21) MESON THEORY OF NUCLEON–NUCLEON INTERACTION. Wong, David Y. (California Univ., La Jolla, San Diego). Feb. 1967. Contract AT(11-1)-Gen-10. 26p. (CONF-670302–2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla.

It is found that a nucleon–nucleon potential can be constructed in terms of the exchange of six mesons: π, σ, η, ρ, ω, and ϕ. The calculation of the potential and the methods for solving for the scattering amplitudes are considered. It is found that a simple model of nuclear forces based on the exchange of correlated mesonic systems is in good agreement with experimental data on nucleon–nucleon scattering. Such a model can be used as a basis for the detailed phenomenological analysis of the data, and it also leads to a qualitative understanding of the nuclear forces in terms of meson–nucleon and meson–meson interactions. (J.F.P.)

21251 THE QUARK MODEL AND ELASTIC BARYON–BARYON SCATTERING. Akyeampong, D. A. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cimento (10), 48A: 519-23(Mar. 21, 1967).

The consequences of the quark model proposed recently by Lipkin and Scheck are investigated for baryon-baryon and baryon-antibaryon scattering. It is found that, apart from the unpleasant prediction $\sigma^{tot}(\bar{p}p) > \sigma^{tot}(\bar{p}n)$, all other predictions are in reasonable agreement with the experiment. (auth)

21252 THE NUCLEON–NUCLEON INTERACTION AND EXCHANGE OF THE $\pi\eta$ SYSTEM. Gauron, P.; Lacombe, M.; Vinh Mau, R. (Facultes des Sciences de Paris et d'Orsay. Institut de Physique Nucleaire, Orsay, France). Nuovo Cim. (10), 47A: 924-8(Feb. 21, 1967). (In French).

The results of an attempt to treat the nucleon–nucleon interaction using the analyticity and unitarity properties of the scattering amplitude are given. A determination is made of the part of the nucleon–nucleon potential associated with a (π,η) system for a comparison with the contributions obtained previously. These results show that the exchange of the ω or $\pi\eta$ system constitutes only some corrections to the exchange of one or two mesons (π), this exchange being necessary to improve the model used for the calculation of the latter contribution. (J.F.P.)

21253 TWO-TEMPERATURE STATISTICAL MODEL FOR PARTICLE PRODUCTION AT HIGH ENERGIES. Wayland, J. R.; Bowen, T. (Univ. of Arizona, Tucson). Nuovo Cim. (10), 48A: 663-75(Apr. 1, 1967).

With the assumption of two characteristic temperatures, one associated with the transverse momentum distribution, the other with the longitudinal, the differential cross section, $d^2N/dpd\Omega$, is calculated from the relativistic quantum statistical mechanical number density. Good agreement with experimental data for pions, kaons and antiprotons is obtained by the fitting of T_0, the transverse temperature, T, the longitudinal temperature, and V_0, the interaction volume. The model is related to a simple physical interpretation. (auth)

21254 ABSORPTIVE EFFECTS IN THE PRODUCTION PROCESS pp yields pN_{33}^*. Roy, D. P. (Tata Inst. of Fundamental Research, Bombay). Nuovo Cim. (10), 48A: 676-85 (Apr. 1, 1967).

The reaction $pp \rightarrow pN_{33}^*$ for the incident-momentum range 6 to 15 GeV/c is studied in the one-pion exchange model, by incorporating the absorption corrections due to other competing channels, following the prescription of Gottfried and Jackson. With a reasonable choice of the final-state scattering parameters, the absorptive effects are found to provide sufficient prunning to the Born amplitude, so as to reproduce the observed forward peak in the angular distribution. The magnitude of the estimated cross section at 6 GeV/c, however, comes out to be three times as large as the observed one. Also the predicted cross section falls somewhat faster with increasing energy as compared to the corresponding experimental quantity. These features are similar to the ones observed earlier for reactions of the type $\pi p \rightarrow \rho N^*$ or $p\bar{p} \rightarrow N^*N^*$, where particles with large spins are involved. (auth)

21255 STUDY OF THE PROCESS $\pi^+ + d \rightarrow p + p$ AT LOW ENERGIES. Rose, Carl M. Jr. (Univ. of Chicago). Phys. Rev., 154: 1305-13(Feb. 25, 1967).

The process $\pi^+ + d \rightarrow p + p$ was studied in the energy range 2–16 MeV. The data are fitted with the phenomenological equation $\sigma = \frac{2}{3}(p^2/\mu^2c^2)(\alpha/\eta + \beta\eta)$, where p is the proton c.m. momentum, μ is the pion mass, and η is the pion c.m. momentum in units of μc. The fitted values are $\alpha = 0.240 \pm 0.02$ mb and $\beta = 0.52 \pm 0.2$ mb. The relationship of this measurement to the results of π^+ photoproduction and pion elastic scattering experiments is reviewed. (auth)

21256 SUPERCONVERGENCE SUM RULES IN NUCLEON–NUCLEON SCATTERING. D'Auria, R.; de Alfaro, V. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 48A: 284-8(Mar. 1, 1967).

The case of nucleon –nucleon scattering is examined in order to establish the possible sum rules, and the problem of saturation is discussed. It is found that saturation of the sum rules in the nucleon–antinucleon channel by the lowest intermediate states yields relations which are consistent with the known values of the coupling constants. It is stressed that the only sensible indication derives from the relative order of the magnitude and sign of the various contributions. (J.F.P.)

21257 MESON–NUCLEON COUPLING CONSTANTS FROM NUCLEON–NUCLEON FORWARD DISPERSION RELATIONS. Carter, A. A. (Cambridge Univ., Eng.). Nuovo Cimento (10), 48A: 15-22(Mar. 1, 1967).

The coupling constants of the ω, η, σ mesons were estimated using the proton–proton forward dispersion relation. The calculations were performed as a function of the σ mass, upon which limits were placed. The ratio of the real to the imaginary part of the elastic proton–proton scattering amplitude was evaluated. (auth)

21258 OPTICAL-MODEL, HIGH-ENERGY p–p SCATTERING AND STRUCTURE OF THE NUCLEON. Islam, M. M. (Brown Univ., Providence). Nuovo Cimento (10), 48A: 251-7(Mar. 1, 1967). (NYO–2262TA-140).

An exact derivation of the eikonal description of the scattering amplitude, a discussion of some of the questions raised by Byers and Yang, and an indication of what the semiphenomenological results may imply about the structure of the nucleon are presented. (J.F.P.)

21259 The $\pi N_{33}^* N_{33}^*$ COUPLING CONSTANT AND THE ADLER–WEISBERGER SUM RULES. Sutherland, D. G. (CERN, Geneva). Nuovo Cimento (10), 48A: 188-96(Mar. 1, 1967).

The $\pi N_{33}^* N_{33}^*$ coupling constant is estimated using Adler–Weisberger techniques as $g_{\pi^+N^{*++}N^{*++}}^2/4\pi = 91^{+27}_{-20}$ and a discussion is given of the comparison with other estimates. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 21408 and 21485.

21260 BASIC PROPERTIES OF POINCARE EXTENSIONS. Yappa, Yu. A. Vestn. Leningr. Univ., No. 22, Ser. Fiz. Khim., No. 4, 7-18(1966). (In Russian).

Relativistic generalisations of an internal symmetry group of elementary particles are studied from the mathematical point of view. Main possibilities existing for such generalisations are classified. (auth)

21261 THEORY OF ELEMENTARY PARTICLE SYMMETRIES. Novozhilov, Yu. V.; Terent'ev, I. A. Vestn. Leningr. Univ., No. 16, Ser. Fiz. Khim., No. 3, 5-17(1966). (In Russian).

Unitary representations of the generalized Poincaré groups ISL (2m,c) and IU (m,m) were considered (SL (2m,c) and U (m,m) are the corresponding homogeneous groups), following the ideas developed by Wigner for the Poincaré group. The problem solved is equivalent to the solution of Dirac-like wave equation for free particles in ISL (2m,c) and IU (m,m) symmetries. The properties of basic matrices Λ_A, $A = 0, 1, \ldots, n^2 - 1$, $n = 2m$ are summarized. The group relations are considered with special emphasis on the properties of n^2-dimensional momenta space of ISL (n,c). The chain of groups ISL (2m,c) $\ni$ IU (m,m) $\ni$ $\overline{\text{ISL}}$ (m,c) is studied, each subsequent group being the subgroup of the preceding one ($\overline{\text{ISL}}$ (m,c) denotes the ISL (m,c)-group with reflection). It is shown how to construct the Wigner operator $\alpha(p)$ which enables one to get a given generalized momentum P from the rest frame. The system of independent normals in n^2-dimensional vector space of ISL (n,c) is introduced in such a way that the problem of finding $\alpha(p)$ is reduced to the one of $d_{\frac{1}{4}} = \text{Sp}(p)^{\frac{1}{4}}$, where $P = p_A\Lambda_A$ is the momentum matrix. The quantity $d_{\frac{1}{4}}$ can be calculated explicitly for $n \leq 4$ in the case of ISL (n,c) and $m \leq 4$ for IU (m,m). In the general case an integral representation for d_s, $0 < S < 1$ is given. (auth)

21262 GROUP ALGEBRA, CONVOLUTION ALGEBRA, AND APPLICATIONS TO QUANTUM MECHANICS. Loewdin, Per-Olov (Uppsala Univ. Univ. of Florida, Gainesville). Rev. Mod. Phys., 30: 259-87(Apr. 1967).

The symmetry group of the Hamiltonian plays a fundamental role in quantum theory in the classification of stationary states and in studying transition probabilities and selection rules. It is here shown that the properties of the group may be given a condensed and transparent description in terms of the convolution algebra, and that Schur's lemma immediately leads to the construction of the fundamental set of projection and shift operators. The projection operators form a resolution of the identity which may be used to split the Hilbert space into orthogonal and noninteracting subspaces of infinite order. The question of the splitting of the conventional secular equations is discussed, and the explicit form of the decomposed equation is derived in terms of the convolution algebra and the characters. The theory is here discussed only for the finite groups, but the results may be generalized to the compact infinite groups having a well-defined "invariant mean." (auth)

21263 GENERAL GRAPHICAL METHOD FOR ANGULAR MOMENTUM. Massot, J.-N.; El-Baz, E.; Lafoucriere, J. (Univ., Lyon). Rev. Mod. Phys., 30: 288-305(Apr. 1967).

A graphical method is presented allowing the representations of "j-m" and "3nj" coefficients, spherical harmonics, irreducible tensor operators, and rotation matrices. Rules are established which permit calculations on expressions with the above elements. As the main difficulty of using "3j" Wigner coefficients is the construction of the phase, an algorithm is proposed which simplifies this problem. Concrete examples are given for this general method. (auth)

21264 GROUP THEORY OF THE POSSIBLE SPONTANEOUS BREAKDOWN OF SU_3. Brout, R. (Univ Libre, Brussels). Nuovo Cim. (10), 47A: 932-4(Feb. 21, 1967).

Some special features are emphasized which were touched upon in a recent investigation by Domokos and Suranyi on spontaneous symmetry breaking in quantum field theory and which are related to breakdown of SU(3). The following two points are discussed: SU(3) being a group of rank 2 is much more unstable with respect to spontaneous breakdown than a group of rank 1; and an octet driven by an octet-type force can maintain solutions which are not broken in the direction of this force, but at directions at 120° with respect to it in weight space. (L.B.S.)

21265 A GENERALIZED REGGE IDENTITY FOR WIGNER COEFFICIENTS. Sharp, R. T. (McGill Univ., Montreal). Nuovo Cim. (10), 47A: 860-8(Feb. 21, 1967).

The fact that the group SU_2 can be embedded in SU_3 in different ways is exploited to derive an identity for the SU_3 Wigner coefficient. When the Wigner coefficient is factored into an SU_2 scalar and an SU_2 Wigner coefficient, the identity relates to the SU_2 Wigner coefficient. One of the Regge identities for the SU_2 Wigner coefficient is shown to be a special case and a slightly more complicated example of the identity is worked out. The transformation matrix from T to R spin eigenstates of an arbitrary irreducible SU_3 representation is evaluated. (auth)

21266 CROSSING MATRIX FOR $(p,q) \oplus (1,1) \rightarrow (p,q) \oplus (1,1)$ IN SU_3. Singh, Y. (Tata Inst. of Fundamental Research, Bombay). Nuovo Cim. (10), 48A: 800-13(Apr. 1, 1967).

Explicit expressions for the elements of the u to s channel crossing matrix for $(p,q) \oplus (1,1) \rightarrow (p,q) \oplus (1,1)$ in SU_3 are worked out by using Clebsch–Gordan coefficients and general properties of the crossing matrices. (auth)

21267 GENERAL PROOF OF CARRUTHERS THEOREM. Jin, Y. S. (Brown Univ., Providence). Phys. Lett., Part B, 24: 411-12(Apr. 17, 1967). (NYO-2262TA-148).

Under the general requirements of Lorentz invariance and mass-spectrum condition, it is shown that the invariance under the isospin group SU(2) implies abnormal commutation relations for bosons (fermions) with half-integer (integer) isospin. (auth)

21268 A METHOD FOR THE SOLUTION OF THE CLASSICAL FOUR-BODY PROBLEM WITH THE HELP OF THE LIE SERIES. Junker, Klaus (Technische Hochschule, Vienna). Acta Phys. Austr., 24: 219-33(1966). (In German).

In the previous uses of the Lie series to the solution of the differential equations system of the classical four-body problem, the scattering theory is always used. In the present study the possibility is shown of obtaining the exact solutions of the four body problem in the form of Lie series so that the coefficients are calculated recursively. It is not possible to find a formation law for the general coefficients $D^j z_i$ of the Lie series. A system of recursion formulas boxed into each other can be derived for $D^j z_i$. Therefore the solution of the problem can be outlined. The same method was applied to a special three-body problem and the pertinent recursion formula system was given. (tr-auth)

21269 CASIMIR OPERATORS FOR UNITARY GROUP. Popov, V. S.; Perelomov, A. M. Yadern. Fiz., 5: 693-6 (Mar. 1967). (In Russian).

A generating function G(z) for the Casimir operators of the unitary group (U(n) or SU(n)) is found. Using G(z) the calculation of the eigenvalues of the Casimir operators is considerably simplified. (auth)

21270 SU_4: CLEBSCH-GORDAN SERIES AND MULTIPLICITY $M^m(m')$ OF A WEIGHT m′ CONTAINED IN THE IRREDUCIBLE REPRESENTATION D(m). Gruber, B. (Istituto Nazionale di Fisica Nucleare, Naples. Matscience Inst., Madras). Nuovo Cimento (10), 48A: 23-42(Mar. 1, 1967).

A formula is given, valid for any of the classical groups, which allows an explicit expression for the Clebsch–Gordan series to be written once the multiplicity structure of $1/\Delta$ is known for a group. Explicit expressions for the Clebsch–Gordan series for the general case as well as for special direct products for SU_4 are given. The Clebsch–Gordan series for SU_3 and SU_2 are rederived from the same formula. (auth)

21271 SU_2 AS A CLASSICAL INVARIANCE GROUP. Han, M. Y.; Stehle, P. (Univ. of Pittsburgh). Nuovo Cimento (10), 48A: 180-7(Mar. 1, 1967).

The two-dimensional classical harmonic oscillator and Kepler systems possess integrals of the motion generating the algebra of SU_2. It is shown by explicit classical construction that the only two-dimensional classical system described by a Hamiltonian $H = T + V$ which is invariant under SU_2 is the isotropic harmonic oscillator. The group for the Kepler system is then necessarily O_3. The meaning of this in terms of the particle orbits is discussed. (auth)

21272 GLOBAL CONDITIONS ON U_6 SYMMETRY. Ryder, L. H. (Univ. of Durham, Eng.). Nuovo Cimento (10), 48A: 172-9(Mar. 1, 1967).

Present particle assignments in SU_6 lead to the following conditions for U_6 symmetry: quarks have fractional charge and baryon number, the Gell-Mann–Nishijima relation holds modulo 2, $(-1)^B = (-1)^{2J}$, B = baryon number, J = spin. (auth)

Applications (Electromagnetic and Weak)

21273 A POSSIBLE STRUCTURE FOR C-VIOLATING ELECTROMAGNETIC INTERACTIONS. Roman, P.; Yun, S. K. (Boston Univ.). Nuovo Cimento (10), 48A: 454-65(Mar. 21, 1967).

In accord with Lee's ideas on discrete space-time symmetries, a phenomenological electromagnetic Hamiltonian H_γ is suggested for hadrons, which contains even-C and odd-C SU_3 tensor components. The simplest consequences of this interaction are explored. It appears that in many instances the C-violating part does not become effective. Further significant tests of the theory are predicted for certain C-violating meson and decuplet baryon electromagnetic decays. Some comments on the possible underlying dynamics are also made. (auth)

21274 NEW APPROACH TO CURRENT ALGEBRA. Katyal, D. L. (National Physical Lab., New Delhi). Nuovo Cim. (10), 47A: 869-73(Feb. 21, 1967).

In this approach the weak currents are constructed from the phenomenological fields of hadrons themselves rather than from quark fields of symmetry group. It is shown that their F-type currents form a closed algebra while D-type do not. However both close the algebra if Y_0^* is taken as the ninth baryon. (auth)

21275 CURRENT ALGEBRA AND BROKEN-SYMMETRIC RELATIONS BETWEEN AXIAL VECTOR COUPLING CONSTANTS. McCliment, E. R. (Max-Planck-Institute for Physics and Astrophysics, Munich). Nuovo Cim. (10), 48A: 735-42(Apr. 1, 1967).

Deviations from SU_3-symmetric axial vector coupling constants are calculated using the commutation relations between the space integrals of the fourth components of the vector and axial vector currents. (auth)

21276 ALGEBRAIC FORMULATION OF DYNAMICAL MODELS. Bisiacchi, G.; Budini, P. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 47A: 792-806 (Feb. 21, 1967).

An algebraic method for the solution of some dynamical problems for a nonrelativistic system with known symmetry properties is given, in the case of the so-called broken symmetry. Examples of solvable models are given. One of these, based on the noncompact group Sp(6,R), given a mass formula for baryons depending on three parameters which reproduces the known masses within electromagnetic mass differences. The model implies the relation $(\Sigma^* - \Sigma)/(\Sigma - \Lambda) = 3/2$ in good agreement with experiment. The mass formula in the model can be considered as an eigenvalue solution of a differential equation in an appropriate Riemannian manifold. Relation with the proposed models and with charge algebras is discussed. (auth)

21277 COULOMB INTERACTION THEORY. Tugov, I. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 616-21(Mar. 1967). (In Russian).

The symmetry of the differential equation in the momentum space for the multidimensional Coulomb problem is investigated. It is shown that this equation is equivalent to the equation for the eigenvalues of the Laplace operator in a space with constant curvature $K > 0$ (the discrete spectrum) or $K < 0$ (the continuous spectrum). The diagonal operators are given explicitly and the continuous spectrum Coulomb functions are constructed in several coordinate systems for the three-dimensional case. It is shown that the wave functions, describing scattering with a given energy in an attractive and in a repulsive field, realize equivalent infinite-dimensional irreducible representations of the Lorentz group, belonging to the principal series of unitary representations. (auth)

21278 BARYON MAGNETIC MOMENTS AND DISPERSION SUM RULES. Cini, M. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); De Maria, M.; Taglienti, B. Nuovo Cimento (10), 48A: 277-80(Mar. 1, 1967).

The problem of the magnetic moments for baryons is reinvesti-

gated with the purpose of finding whether the system of all the independent algebraic equations between matrix elements of currents, obtained by taking into account in the Fubini sum rules, the contribution of an SU(3) singlet (for example Y_0^* (1405)) state in addition to the ones of octet and decuplet, has a nonvanishing consistent solution. For this purpose the explicit assumption is made that the weak axial coupling constants are connected by SU(3) symmetry leaving the parameter D/F undetermined. Only isotopic symmetry is assumed for the baryon magnetic moments and the baryon resonance transition moments. It is found that the minimal set of intermediate states leading to a nonvanishing result for the magnetic moments contains besides octet and decuplet, an SU(3) singlet, that the D/F ratio for weak constants corresponding to this solution is 3, and that the magnetic moments obtained are the same as those given by SU(3) for $(D/F)_{magn} = 3$, if one makes the additional assumption $[(\mu_\gamma(N)/\mu_s(\Lambda)) = (2/\sqrt{3})]$. (J.F.P.)

Applications (Strong)

Refer also to abstract 21421.

21279 DECOMPOSITION OF THE TENSOR PRODUCT OF TWO IRREDUCIBLE REPRESENTATIONS OF SL(3,C). Mebkhout, Mohamed (Faculte des Sciences, Marseille). Compt. Rend., Ser. B, 264: 105-7(Jan. 9, 1967). (In French).

The unification of U(P,M), where P is the Lie algebra of the Poincaré group and M that of SL(3,C), was proposed previously for the description of the systems of strong interactions. From this is posed the question of the decomposition of the tensor product of irreducible representations of this last group. A description of this problem is proposed. (J.S.R.)

21280 THEORY OF OCTET ENHANCEMENT AND THE PSEUDOSCALAR VECTOR MESON INTERACTION. Contogouris, A. P.; Diu, B.; Pusterla, M. (CERN, Geneva). Nuovo Cimento (10), 48A: 430-53(Mar. 21, 1967).

The possibility of a dynamical octet enhancement in the perturbation patterns of the vector meson octet is studied by means of the Dashen–Frautschi technique. For the case in which the vector octet corresponds to a resonance in pseudoscalar-pseudoscalar scattering, the formalism pertinent to this study is developed in detail. Application of an unperturbed SU_3 symmetric amplitude taken from a self-consistent model investigated by the authors shows that the relevant mass coupling shift matrix has an eigenvalue very close to unity both in the eight- and 27-representation ($x_8 = 0.98$, $x_{27} = 0.92$). An appropriate parametrization of the model indicates no qualitative difference in the magnitude of the important eigenvalues of these two representations, thus giving no unambiguous enhancement of the eight over the 27. (auth)

21281 MASS RELATIONS FOR THE 56, 70, AND 20 REPRESENTATIONS IN A QUARK MODEL. Hendry, A. W. (National Inst. for Research in Nuclear Science, Chilton, Eng.). Nuovo Cim. (10), 48A: 780-7(Apr. 1, 1967).

Mass relations for the baryons in the 56, 70 and 20 representations of SU_6 are derived in a quark model. Given the masses of a few of the baryons, the masses of all the remaining baryons in these representations can be determined. (auth)

21282 EXISTENCE OF A 189-PLET OF MESONS. Silbar, R. R. (Catholic Univ. of America, Washington, D. C.). Nuovo Cim. (10), 47A: 700-6(Feb. 21, 1967).

The 2^+ meson monet is assumed to be part of a 189-dimensional representation of SU_6. A mass formula for the representation is presented and used to search for the missing 0^+ and 1^+ states. Generalized Schwinger relations are obtained and compared with experiment. Using the five best established meson states—f, A_2, K**, D, and E—the masses of all states are predicted. The general conclusion is that there is no evidence that a 189 multiplet is present in the meson spectrum. (auth)

21283 REPRESENTATION MIXING IN $\tilde{U}_{12}$. Nwachuku, O.; Mahanta, P.; Akyeampong, D. (Imperial Coll. of Science and Tech., London). Nuovo Cim. (10), 47A: 730-4(Feb. 21, 1967).

Some consequences of the assumption that the physical baryons belong to some mixed representations of $U_{6,6}$ are studied in the context of the 3-point, electromagnetic and weak vertices and the 4-point Johnson-Treiman relations. (auth)

21284 BARYON–BARYON SYSTEM IN THE SINGLET STATE. Ranft, Gisela. Wiss. Z. Karl-Marx-Univ., Leipzig, Math.-Naturwiss. Reihe, 13: 481-4(1964). (In German).

It was shown that the singlet baryon-baryon state $^1S_0$ can be related to the 27(2,2) representation with baryon number 2. The coefficients of the Gell–Mann and Okubo mass formula were calculated for the 27(2,2) multiplet. (J.S.R.)

21285 DERIVATION OF STRONG INTERACTIONS FROM A QUARK MODEL. Freund, Peter G. O.; Predazzi, Enrico (Univ. of Chicago). Physics, 3: 81-94(Feb. 1967). (COO-264-323; EFINS-66-46).

A model of mesons as quark-antiquark bound states is presented. The model is based on a zero range approximation and SU(3)-symmetry. It yields the following results: The couplings of the mesons to quarks can be calculated and they conform to the same pattern that would be followed by couplings among multiplets of the group $U(6) \times U(6) \times O(3)$. Thus $U(6) \times U(6) \times O(3)$ symmetry emerges as a consequence of the dynamical features of the model. Beyond the high symmetry that it produces, the model predicts the numerical value of the universal strong coupling constant in terms of the ratio of meson to quark masses. This fact when used in conjunction with the experimentally known value of the universal strong coupling constant leads to a very low value for the quark mass M, namely $M \approx \frac{1}{2} \times$ (central meson mass). Using this value for the quark mass, the $\pi \to \mu\nu$ decay rate is estimated from the quark model in much the same way as one calculates the 2γ decay rate of parapositronium. The result agrees remarkably well with experiment. It is argued that the possible existence of quarks with a mass of the order of half a BeV may not be excluded by existing experiments. (auth)

21286 ON THE SU_6 REPRESENTATIONS FOR THREE-BARYON STATES. Ram, B. (New Mexico State Univ., University Park). Nuovo Cimento (10), 48A: 258-61(Mar. 1, 1967).

A study of all the irreducible representations which occur in the Kronecker product of $56 \times 56 \times 56$ is presented, and some qualitative remarks are made about the most appropriate representation for the classification of the three-baryon states. These representations are listed. (J.F.P.)

21287 SU(3) REACTION INEQUALITIES AT HIGH ENERGIES. Meshkov, S. (National Bureau of Standards, Washington, D. C.); Yodh, G. B. Phys. Rev. Lett., 18: 474-9(Mar. 20, 1967).

SU(3) reaction inequalities which were thought to be violated are re-examined and found to agree with experiment at high energy. The comparison is made for both integrated and forward amplitudes. The apparent validity of SU(3) puts limits on the high-energy behavior of the amplitude differences $|M(K^- + p \to K^- + p) - M(\pi^- + p \to \pi^- + p)|$ and $|M(K^+ + p \to K^+ + p) - M(\pi^+ + p \to \pi^+ + p)|$. (auth)

Quantum Field Theories

21288 (NP-16674) DESCRIPTION OF ALL SELF-ADJOINT EXTENSIONS OF THE FIELD OPERATORS. Gachok, V. P. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1966. 36p. Dep. mn.

A description of all self-adjoint extensions of a field operator $A(f_1)$, $f_1(x)$, a real function, is given. The essential assumption about the functional W(f) is the density of the domain together with continuity and the positive definiteness of W(f). These conditions permit it to be proven that a field operator $A(f_1)$ has the deficiency index of the form (m,m) where m may take any one of the integers $0, 1, \ldots, \infty$. (J.F.P.)

21289 WHEN CAN HIDDEN VARIABLES BE EXCLUDED IN QUANTUM MECHANICS? Misra, B. (Univ. of Geneva). Nuovo Cim. (10), 47A: 841-59(Feb. 21, 1967).

The problem of hidden variables is examined in the axiomatic formulation of quantum mechanics based on the algebra of observables. After a brief introductory survey of the earlier investigations, the structure of C*-algebras which allow dispersion-free positive linear functionals is investigated. The result obtained is a direct generalization of the well-known result of von Neumann concerning the hidden variables. In the next Section, it is assumed as before, that the observables form the Hermitian elements of a C*-algebra. But now the requirement on "states" and the so-called monotone-positive functionals (which are not necessarily linear) are allowed to represent states. It is then shown that even when such generalized states are allowed, a system admits hidden variables only if its algebra of observables is Abelian; i.e., only if all observables are mutually compatible. In another Section, the question of hidden variables under the assumption that the observables, instead of forming a C*-algebra, have a certain more general algebraic structure. (auth)

21290 SUM RULES AND JOST–LEHMANN–DYSON REPRESENTATION. Gervais, J. L.; Le Bellac, M. (Faculte des Sciences, Orsay, France). Nuovo Cim. (10), 47A: 822-40(Feb. 21, 1967).

The Jost-Lehmann-Dyson representation is applied to study the matrix elements of current commutators between spinless one-particle states. The method generalizes the one proposed by Stichel and Schroer. The sum rule of Fubini is derived from

assumptions on the behavior at infinity of certain spectral functions, while difficulties are shown to arise from the sum rules already obtained from time derivative in the Breit system. The equal-time limits of the matrix elements are studied and sufficient conditions are given so that the commutators involving, at least one time component, take the form of the quark model. This is shown to be impossible for the commutator of space components. It is pointed out, in the conclusion, that the hypotheses leading to the equal-time limit are much stronger than the ones which are sufficient to get Fubini's sum rule. (auth)

21291 ELEMENTARY AND COMPOSITE PARTICLES IN FIELD THEORY. II. Alexanian, M.; Zimmerman, R. L. (Univ. of California, Livermore). Contract W-7405-eng-48. Nuovo Cim. (10), 48A: 709-20(Apr. 1, 1967). (UCRL-14808-T(Pt.2)).

The elementary or composite nature of particles is studied in the context of Lagrangian field theories when there exist several particles with the same quantum numbers but differing in mass. It is shown that there exist two possible wave function renormalization constants. One of them, $\tilde{Z}_3^{(i)}$, gives the high-energy behavior of the particles' propagator, whereas the vanishing of the other, $Z_3^{(i)}$, establishes the particle as composite. Hence, the knowledge of the high-energy behavior alone does not establish definitely the composite nature of a particle. (auth)

21292 SPECTRAL REPRESENTATIONS FOR ANY SPIN. I. IRREDUCIBLE FIELDS. Raszillier, I. (Inst. of Physics, Bucharest); Schiller, D. H. Nuovo Cim. (10), 48A: 617-34 (Apr. 1, 1967).

Spectral representations for the two-point functions, the vacuum expectation value of the commutator (or anticommutator) and the propagator of the $2(2j + 1)$-component "irreducible" interacting field of any spin j are given. The calculations were done assuming first only Lorentz and CPT-invariance, then imposing CP-invariance. These requirements reduce the number of independent real spectral functions from four to three and two, respectively. For $j \leq 1/2$ the already known results are reobtained. (auth)

21293 SPECTRAL REPRESENTATIONS FOR ANY SPIN. II. TENSOR FIELDS. Raszillier, I. (Inst. of Physics, Bucharest). Nuovo Cim. (10), 48A: 635-44(Apr. 1, 1967).

The spectral representations for tensor fields are derived along the lines developed previously for irreducible fields. The consequences of the supplementary conditions as well as the restrictions imposed by CP- and P-invariance are investigated. The propagators are given again in the form of (unconditional) projection operators multiplied by some (analytic) functions. (auth)

21294 SPECTRAL REPRESENTATIONS FOR ANY SPIN. III. RARITA-SCHWINGER FIELDS. Novacu, V.; Raszillier, I. (Inst. of Physics, Bucharest). Nuovo Cim. (10), 48A: 645-54 (Apr. 1, 1967).

Spectral representations are given for the Rarita-Schwinger fields, imposing as in the previous papers successively Lorentz, CPT-, CP- and P-invariance. The implications of the supplementary conditions and finally some aspects of their application are discussed. (auth)

21295 LIMITATION OF THE SCHWINGER TERMS. Tonin, M. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim. (10), 47A: 919-23(Feb. 21, 1967).

Covariance arguments are used to show that, under suitable assumptions, strong limitations can be obtained for the Schwinger terms. In particular, it is shown for instance that no derivative of δ-functions of order higher than the second (second-order Schwinger terms) can be present in the equal-time commutators of the current. Moreover, such Schwinger contributions are completely expressed in terms of the commutators of the fields and the first-order derivatives with the current. (L.B.S.)

21296 REGGE-POLE BEHAVIOR IN AN $SL_{2,C}$ MODEL FIELD THEORY. Cocho, G.; Ar-Rashid, Harun (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 47A: 874-89 (Feb. 21, 1967).

A model $SL_{2,C}$ field theory proposed by Fronsdal was employed to evaluate a strong-interaction vertex. Using this vertex function and an assumed mass spectrum of the exchanged $SL_{2,C}$ tower in a Feynman diagram, the high-energy and low momentum transfer part of the amplitude was extracted out. This shows characteristic Regge behavior and compares favorably with the proton-proton scattering data, although the numerical agreement is not considered significant in this model study. (auth)

21297 HYPERBOLIC FOLDING OF SOLUTIONS OF THE GENERAL FIELD EQUATION. Weier, Josef. Acta Phys. Austr., 24: 193-209(1966). (In German).

It is shown that with the hyperbolic folding as a product the solutions of the field equations $\Box - m^2 = 0$ forms an algebra. The algebra is associated and not zero-part three. The algebra of the solution of this scalar field equation with the hyperbolic folding as a product yields simultaneously a solution algebra of the four-component spinor field equation. (J.S.R.)

21298 ON THE ASYMPTOTIC BEHAVIOR OF THE GREEN FUNCTIONS IN QUANTUM FIELD THEORY. Tarasov, Yu. A. Zh. Eksp. Teor. Fiz., 52: 742-55(Mar. 1967). (In Russian).

A set of renormalized equations for the nucleon and meson Green functions and the vertex part is derived on basis of the set of linked quantum field theory equations in the form of a series in powers of the coupling constant λ. An asymptotic investigation carried out by taking into account terms $\sim\lambda^3$ shows that the "anti-Lehman" behavior of the Green functions in pseudoscalar meson theory and electrodynamics found in the first approximation is fundamentally the same even when higher approximations are taken into account. (auth)

21299 INDUCED PHOTON SPLITTING IN AN ELECTROMAGNETIC FIELD. Varfolomeev, A. A. Zh. Eksp. Teor. Fiz., 52: 756-8(Mar. 1967). (In Russian).

The interaction of two photon beams of different frequency in the presence of a static external electric field is considered. The cross section for induced splitting of the photon of larger frequency due to interaction of the fourth order is derived. Numerical estimates of the splitting cross section in the coulomb field of a finite radius charged sphere are presented. (auth)

21300 INFRARED SINGULARITIES OF THE GREEN FUNCTION IN ARBITRARY GAUGE. Zhuravlev, V. I.; Solov'ev, L. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 52: 702-5(Mar. 1967). (In Russian).

All singular terms in the infrared region are determined for the Green function of charged particle of arbitrary gauge in all orders of e. (auth)

21301 ON SEGAL'S NEW QUANTUM FIELD THEORY. I. PIONS INTERACTING WITH AN EXTERNAL ELECTROMAGNETIC FIELD. Corbella, O. D.; Gleiser, R. J.; Hamity, V. H.; Kalnay, A. J. (Univ. Nacional de Cordoba, Argentina). Nuovo Cimento (10), 48A: 115-31(Mar. 1, 1967).

Segal's ideas are applied to a more general case than the one used in the development of the theory, studying a classical field that depends, as well as on the space-time variables, on a discrete index, and whose evolution equation contains terms dependent on the first derivatives of the field as well as functions of the space-time variables. The explicit form of the quantum field, its commutation rules, and its equation of evolution are obtained. Specializing these results to the case of a complex (pseudo) scalar field interacting with an external electromagnetic field, the expressions obtained coincide formally with those of current formulations of the quantum theory of fields. (auth)

21302 LEHMANN-SYMANZIK-ZIMMERMANN FORMALISM IN THE LEE MODEL WITH HEAVY BOSONS. Scarfone, L. (Vermont Univ., Burlington). Nuovo Cimento (10), 48A: 84-91 (Mar. 1, 1967).

The Lehmann–Symanzik–Zimmermann formalism is used as a calculational technique to solve the $V + nN \rightarrow (n + 1)N + \theta$ ($n = 0, 1, 2, \ldots$) sectors of the Lee model with heavy bosons. (auth)

21303 LAGRANGIAN FIELD THEORY OF THE RARITA-SCHWINGER FIELDS WITH SPIN 5/2. Kawakami, A.; Kamefuchi, S. (Tokyo Univ. of Education). Nuovo Cimento (10), 48A: 239-44(Mar. 1, 1967).

A special case of the Lagrangian formalism is discussed. This case is that of Rarita–Schwinger fields with mass $m \neq 0$ and spin 5/2. (J.F.P.)

Scattering Theory

21304 (JINR-P5-3179) FUNKTSIONAL'NAYA FORMULIROVKA AKSIOM BOGOLYUBOVA, OPREDELYAYUSHCHIKH PRICHINNUYU S-MATRICHNUYU TEORIYA. (Functional Formulation of the Bogolubov Axioms Determining the Causal S-Matrix Theory). Khodzhaev, L. Sh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 22p. (In Russian). Dep. mn.

A functional formulation of the Bogolyubov axioms, determining the causal S-matrix theory, is given in order to associate it in future with the Wightman axiomatic quantum theory. (auth)

21305 A DISPERSION FORMULA FOR POTENTIAL SCATTERING. Mercier, R. P. (Univ. of Glasgow). Proc. Phys. Soc. (London), 90: 925-34(Apr. 1967).

For the class of potentials vanishing beyond a certain point, a

new dispersion formula is derived in which the scattering matrix S(k) is written as the ratio of two conditionally convergent partial fraction sums. The numerator displays the poles of S(k) at the complex eigenvalues k_n and the denominator displays poles at $-k_n$, the zeros of S(k). The expression is manifestly unitary and remains so when an approximation depending only on a finite number of poles is made. Besides the S-wave theory, higher-wave scattering is treated, and among particular illustrations is a generalization to higher waves of the effective-range approximation. (auth)

21306 OSCILLATIONS OF SCATTERING AMPLITUDES AT HIGH ENERGY. Eden, R. J.; Lukaszuk, L. (Cambridge Univ., Eng.). Nuovo Cim. (10), 47A: 817-21(Feb. 21, 1967).

Various problems are discussed that relate to oscillations in high-energy scattering. It is shown 1) that oscillations as $s \to \infty$ of a scattering amplitude F(s,t) are not restricted by a polynomial bound and analyticity in s, 2) that for sufficiently large s, the number N(s,r) of zeros of F(s,t) within $|t| < r < t_0$ (where t_0 is the nearest singularity) satisfies $N(s,r) < C \log s$, where C is a constant. (auth)

21307 ANALYSIS OF RESONANCES WITH WAVE-PACKET BEAMS. Beaupre, J.; Sertorio, L. (Ames Lab., Iowa). Contract W-7405-eng-82. Nuovo Cim. (10), 47A: 685-99(Feb. 21, 1967). (IS-1353).

A simple spinless scattering in which many near resonances of the system can be excited is analyzed. A wave packet treatment permits the analysis of the time dependence of the wave function as modified by the long-lived states. This effect, together with the natural width of the packet gives a cross section which is different from the result coming from a time-independent treatment. Choosing an algebraic form for the packet exact results are derived for the case of two near resonances. (auth)

21308 INELASTIC SCATTERING FROM REAL POTENTIALS. Spector, R. M. (Wayne State Univ., Detroit). Nuovo Cim. (10), 48A: 817-19(Apr. 1, 1967).

It is shown that the attractive real singular potential problem can be well defined by providing a unique choice of wave function at the origin. (L.B.S.)

21309 ON THE FREDHOLM METHOD FOR THE LIPPMANN-SCHWINGER EQUATION. Smith, J. (Univ. of Adelaide). Nuovo Cim. (10), 48A: 788-99(Apr. 1, 1967).

Noyes' factorization of the off-shell T-matrix into a function determined entirely by the off-shell Born approximation times the on-shell T-matrix reduces considerably the complexity of the three-particle Faddeev equations. Also, as a byproduct, it gives a new method of calculating the on-shell T-matrix, which is shown to yield better results, for the exponential and Yukawa potentials, than the analogous methods of S-matrix theory. (auth)

21310 NEW APPROACH TO THE MULTICHANNEL SCATTERING THEORY. Sato, S. (Rikkyo Univ., Tokyo). Nuovo Cim. (10), 48A: 721-34(Apr. 1, 1967).

A new approach to the theoretical treatment of scattering processes which involve composite particles is investigated by using a nonrelativistic model of the second-quantized form. Starting from an original Hamiltonian which allows the existence of a composite system, an effective Hamiltonian is constructed so that every possible process can be treated in a unified way. The results obtained show fairly reasonable characters to some extent from the physical point of view, and the present method may serve as a new formulation of the multichannel scattering. (auth)

21311 NONSIMPLE PHYSICAL-REGION SINGULARITIES OF THE S-MATRIX. Storrow, J. K. (Cambridge Univ., Eng.). Nuovo Cim. (10), 48A: 593-616(Apr. 1, 1967).

A certain class of nonsimple singularities is analyzed by S-matrix methods. A nonsimple singularity is one whose Landau-Cutkosky diagram does not consist of a network of single lines. The positive-α condition and the Cutkosky formula are deduced, in agreement with perturbation theory. (auth)

21312 UNITARITY CONDITION AND ASYMPTOTIC PROPERTIES OF A SCATTERING AMPLITUDE. Roizen, I. I. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 5: 663-8 (Mar. 1967). (In Russian).

Assuming that the total cross section is not a power function of s and that the elastic scattering amplitude is a sufficiently smooth function of t at $|s/t| \to \infty$ it is shown that if $t < 0$ the analyticity domain boundary for the partial wave amplitude f(l,t) in the l-plane is the straight line $l = 1$. The character of the fixed singularity at $l = 1$ is unknown and may depend on t. If this singularity is a simple pole at $t = 0$ then its character does not depend on t. Such a singularity results in a nonshrinking diffraction peak. (auth)

21313 VERTEX RENORMALIZATION IN DIRAC POTENTIAL SCATTERING. Rockmore, R.; Kafrissen, E. (Rutgers-The State Univ. of New Jersey, New Brunswick). Nuovo Cimento (10), 48A: 72-83(Mar. 1, 1967).

Two methods for studying the properties of the vertex renormalization constant in Schrödinger potential theory in the case of bound states are extended to Dirac scattering. For purposes of illustration, the properties of a ($\frac{1}{2}^+$) bound state vertex are treated in detail. The potential is assumed to transform like a Lorentz scalar, and a derivation is given of Sato's wavefunction normalization condition in the Dirac case subject to this limitation. (auth)

21314 SOME COMMENTS ON PHENOMENOLOGICAL ASPECTS OF REGGE TRAJECTORIES. Dreitlein, J.; Mahanthappa, K. (Univ. of Colorado, Boulder). Nuovo Cimento (10), 48A: 275-6(Mar. 1, 1967).

For the discussion of Regge trajectories restriction is made to those cases in which the fits are achieved by including direct-channel resonance poles in addition to the crossed-channel Regge trajectories. An attempt is made to determine whether such fits could be consistently interpreted as success of the Regge trajectory hypothesis or whether they imply something more than that. For the sake of simplicity of argument the discussion is restricted to the Barger–Cline parameterization. The gist of the argument is that the coherently added Regge amplitudes and the direct channel resonance amplitudes are not dynamically independent and so cannot be independently specified if the physical interpretation of each is to be retained. (J.F.P.)

21315 FACTORIZATION OF HELICITY AMPLITUDES AT HIGH ENERGIES. Fox, G. C.; Leader, Elliot (Cambridge Univ., Eng.). Phys. Rev. Lett., 18: 628-9(Apr. 10, 1967).

It is shown that previous results on the factorization of helicity amplitudes at high energies generalize in a very simple way to arbitrary scattering processes involving particles of arbitrary mass and spin. (J.F.P.)

21316 MODIFIED REGGE REPRESENTATIONS OF THE KHURI TYPE. Kretzschmar, Martin (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Phys., 201: 33-51 (1967).

The unmodified Regge pole contribution to a scattering amplitude shows several undesirable features: As a function of z it exhibits spurious singularities and for Re $\alpha < -1$ it becomes an asymptotically increasing function, a behavior which may lead to difficulties in comparisons with experimental data. Khuri has described a modified Regge representation which has much improved properties. Modifications of the same type are investigated in a more systematic way. It is shown that several classes of modified representations can be derived, Khuri's representation being contained in one of these. Some of these representations can be excluded, when a threshold behavior like that of the physical amplitude or when a decreasing asymptotic behavior for Re $\alpha < -1$ is required. A certain function named "Khuri function" that can be looked at as a generalized Legendre function plays a distinguished rôle. Some of the mathematical properties of this function are derived. (auth)

21317 CONNECTION BETWEEN ANOMALOUS THRESHOLDS AND SINGULARITIES IN THE EXTERNAL MASSES OF THE VERTEX AND BOX DIAGRAMS. Rothe, Heinz J. (Univ., Heidelberg). Z. Phys., 201: 87-98(1967).

A study is made of the mechanism which generates the singularities in the legs of the Feynman amplitudes associated with the vertex and box diagrams; it is found that these singularities are very closely tied to the existence of anomalous thresholds for sufficiently large values of the external masses. (auth)

21318 S-MATRIX IN THE FOUR-FERMION THIRRING MODEL. Astakhov, A. V.; Zav'yalov, O. I.; Sukhanov, A. D. (Mathematics Inst., Moscow). Zh. Eksp. Teor. Fiz., 52: 780-6(Mar. 1967). (In Russian).

The relation between the traditional solution of the four-fermion Thirring model and the results of perturbation theory are considered. Summation of the total set of Feynman diagrams for the scattering operator is performed. The expression obtained is identical with the familiar Glaser–Berezin solution. This circumstance is, however, essentially connected with the zero mass and with analysis of the matrix elements only on the mass shell. (auth)

Particle Accelerators

Refer also to abstracts 19833, 20013, 20971, 21012, and 21608.

21319 (BNL-11199) SUPERCONDUCTING BEAM HANDLING EQUIPMENT. Britton, R. B.; Sampson, W. B. (Brookhaven Na-

tional Lab., Upton, N. Y.). [1966]. Contract AT(30-2)-Gen-16. 10p. (CONF-670307-28). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

The conventional quadrupole and dipole magnets, used to focus and bend the beams of charged particles produced by accelerators, consume very large amounts of power. Superconducting magnets are an attractive method of reducing this power requirement while offering the advantage of higher fields and field gradients. A number of model superconducting beam handling magnets have been built and tested and a full-size quadrupole doublet is under construction. The use of high current density Nb_3Sn conductors allows compact design, reducing the cryogenic requirements and capital cost of the magnets. (auth)

21320 (CERN-65-39) STORAGE RINGS AND TANGENT ACCELERATORS. Meunier, R.; Spighel, M.; Stroot, J. P. (European Organization for Nuclear Research, Geneva (Switzerland)). Dec. 1, 1965. 16p. Dep. mn.

A comparative study of the performance of intersecting storage rings at 25 GeV as described in CERN-542 with that of two tangent accelerators is presented. (B.G.D.)

21321 (INR-764/II, III/E) PULSED ELECTRON BEAM VAN DE GRAAFF ACCELERATOR. Sawicki, A.; Rzewuski, H.; Orzechowski, T.; Hentszel, A.; Werner, Z.; Merski, K. (Institute of Nuclear Research, Warsaw (Poland)). Nov. 1966. 23p. Dep.

The adaptation of the dc electron Van de Graaff accelerator for pulse irradiation made by the Laboratory II and III of the Institute of Nuclear Research at Swierk is described. The accelerator with the dc beam was put into operation in 1965 and was adapted in 1966 for pulse radiation damage investigations in semiconductors. (auth)

21322 (JINR-P1-3189) IZMERENIE POLYARIZATSII PUCHKA PROTONOV S ENERGIEI 635 MeV. (Measurement of 635 MeV Proton Beam Polarization). Zul'karneev, R. Ya.; Nadezhdin, V. S.; Satarov, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 6p. (In Russian). Dep. mn.

The results are reported of polarization measurements of the proton beam obtained by scattering on a Be target inside the synchrocyclotron and used in scattering experiments beginning from 1960. A method and the procedure of experimental measurements of azimuthal asymmetry for 350, 596, 635 MeV in pp-scattering at various angles are described. Possible contributions of false asymmetries into experimentally found values are analyzed. The weighted mean over all the beam polarization measurements was obtained by the time-invariant method and turned out to be 0.425 ± 0.013. (auth)

21323 (UCRL-17273) DIGITAL COMPUTER CONTROL OF THE BEVATRON INFLECTION SYSTEM. Lancaster, H. D.; Machen, D. R. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 18, 1967. Contract W-7405-eng-48. 12p. (CONF-670307-23). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

A program is being carried out at the Bevatron, in cooperation with the 200-BeV Design Study, to investigate the application of computerized digital control to accelerators. Specifically, a digital-computer control system has been placed in operation at the Bevatron injector for investigation of control and operator interaction between an on-line control computer and an operating accelerator. The system controls transport and inflection of the 19.3 proton beam. The computer, which is remotely located from the accelerator, collects and disseminates control information through time-shared, hybrid (analog-digital) interface hardware. Data transmission is via twisted pair cable. With this system the beams center of gravity has been maintained at the entrance of the achromatic inflector, in the transverse planes, to ±0.1 mm and ±0.1 mrad by closed loop sampled-data control of steering magnets at three points along the beam-transport channel. Beam position information is obtained from 200-MHz resonant induction electrodes located near each steering magnet. In addition, the inflector deflection and focussing elements may be set by the operator and then regulated automatically by the computer. The operator may request typewritten or cathode-ray-tube (CRT) alphanumeric display or a CRT plot of parameters of interest. Optimization of the circulating charge in the accelerator by automatic adjustment of the inflector magnets and on-line diagnostics of certain injector components during trouble periods are planned. (auth)

21324 (UCRL-70183) ROTATING NEUTRON TARGET SYSTEM. Booth, Rex (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 27, 1967. Contract W-7405-eng-48. 13p. (CONF-670307-24). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

A D-T neutron target system with a 30- to 40-hour half-life was developed that yields 1 to 2×10^{12} neutrons per sec. This system uses a target that is rotating at 1100 rpm. The good success of this system indicates that this type of target system may be capable of being used at much higher beam power levels. Calculations indicate that a beam power of 100 kW and a beam density of 10 kW/cm^2 can be handled with a front target temperature of less than 250°C. (auth)

21325 (BNL-tr-55) PROGRESS REPORT ON THE VEPP-2 POSITRON-ELECTRON STORAGE RING. Auslender, V. L.; (and others). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Paper Presented at the International Conference on High Energy Accelerators, 5th, Frascati, September 9-16, 1965. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Progress on the VEPP-2 positron-electron storage ring is reported. Topics include the synchrotron-injector startup, development of high current in the storage ring, investigation of the beam resonator interaction instability, and critical experiments of the positron storage. (B.G.D.)

21326 ON A MAGNETIC FIELD ARRANGEMENT WITH VARIABLE FOCUSING PROPERTIES. Schramm, H. (Univ., Frankfurt am Main). Z. Angew. Phys., 22: 417-20(1967). (In German).

The focusing properties of a Helmholtz's arrangement with a third coil placed symmetrically in the middle plane the current flowing in opposite direction are investigated. The equation of the potential moulds in which the particles move is communicated and the effect of a coil of rectangular section upon field properties is calculated. The notion degree of focusing instead of the notion field index is ventilated. (auth)

21327 POSSIBILITY OF STIGMATIC IMAGES WITH QUADRUPOLE LENSES. Junior, P.; Antony-Spies, P. (Univ., Frankfurt am Main). Z. Angew. Phys., 22: 420-5(1967). (In German).

The study of quadrupole lens systems and their properties of forming stigmatic images leads to the following alternatives: None, one, two or infinite conjugate object image pairs are possible. The image is in the first case astigmatic, in the second case stigmatic and free of distortion, in the third case stigmatic and distorted and in the last case newtonian and free of distortion. In particular the quadrupole singulet only gives images, where neither object nor image are real or one is real and the other virtual. At least two quadrupoles are necessary to form a stigmatic and real image, but this is still distorted. Yet virtual images which are free of distortion are possible in this case. Real images without distortion are obtained by systems of at least 3 quadrupole lenses. (auth)

21328 SPECIAL PROBLEMS IN ELECTRON SYNCHROTRONS. Leibrecht, K. Z. Angew. Phys., 22: 433-47(1967). (In German).

In circular accelerators the particles being accelerated always lose some of their energy through synchrotron-radiation, the latter being caused by the curvature of the orbit. In the largest electron synchrotrons these losses are so high that they can only be replaced by extremely high accelerating voltages. High accelerating voltages can only be generated with accelerating resonators of a high quality factor, approximately 50,000. In resonators of such high quality, however, the accelerated particles themselves induce voltages which modify the amplitude and phase of the accelerating voltage so that the particles cannot be held in orbit. If it is not possible to compensate the feedback of the beam to the accelerating system and the effect on its own behavior, the accelerated current will decrease rapidly to a low value by which it no longer has any notable influence on the accelerating voltage. (auth)

21329 SELECTOR OF CONTINUOUS X FREQUENCIES DEVELOPED FOR THE ORBITAL RADIATION OF THE FRASCATI SYNCHROTRON. Barchewitz, Robert; Montel, Marc; Bonnelle, Christiane (Faculte des Sciences, Paris). Compt. Rend., Ser. B, 264: 363-6(Jan. 30, 1967). (In French).

A device which makes it possible to eliminate the short wave length of the continuous x spectrum emitted by the Frascati synchrotron was developed. Associated with a crystal spectrograph, it makes possible the carrying out of a continuous measurement program in frequency reflector capacities and absorption coefficients between 2 and 25 Å. (tr-auth)

21330 IMPROVEMENT OF THE ELECTRIC YIELD OF A DUOPLASMATRON ION SOURCE WITH EXPANSION CUVETTE. Gautherin, Guy (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. B, 264: 367-70(Jan. 30, 1967). (In French).

It is shown that the ion losses on the walls of the expansion

cuvette depend on the residual magnetic field and it is possible to reduce them significantly (and therefore to obtain more intense extracted currents) by using a cuvette with insulating wall. (tr-auth)

21331 LIMITING CURRENT DENSITY IN LINEAR ION ACCELERATOR. Zotob, A. V.; Teplyakov, V. A. At. Energ. (USSR), 21: 356-60(Nov. 1966). (In Russian).

For the initial portion of a linear ion accelerator in which the diameter of the particle bunch is much greater than its length, the differential equation of separation and its solution were found for three different functions of the distribution of the charge density in phase space. The solution of the equation makes it possible to evaluate the limit current density in the accelerator. (tr-auth)

21332 BEAM CURRENT DEPENDENCE ON ACCELERATING VOLTAGE IN JINR PHASOTRON. Danilov, V. I.; Enchevich, I. B.; Polferov, E. A.; Safonov, A. N. At. Energ. (USSR), 21: 402-3(Nov. 1966). (In Russian).

For explanation of the theoretical dependence of the beam intensity on the accelerating voltage and for clarification of the possibility of the greatest increase of the intensity of the JINR synchrocyclotron, a series of experiments were carried out to determine the dependence of the accelerated particle beam on the voltage. The results are given graphically. At a radius of 90 cm two curves were obtained, one of which appears as a cubic parabola and the second is described by the $U_g^{\frac{1}{2}}$ rule (U_g = accelerating voltage). An increase of the accelerating voltage leads to an increase of the intensity in comparison with the existing levels by 1.65 times. (J.S.R.)

21333 DETERMINATION OF VIOLATION OF ACCELERATOR PARAMETERS ON INFORMATION ABOUT LOST PARTICLE DISTRIBUTION. Karabekov, I. P. At. Energ. (USSR), 21: 404-6(Nov. 1966). (In Russian).

The method of analysis of the azimuthal distribution of lost particles was examined in order to determine the perturbation of the field in the magnetic system of the accelerator and to measure the parameters of the coherent phase oscillations. (J.S.R.)

21334 EFFICIENCY OF BETATRONS IN DEFECTOSCOPIC STUDIES. Vorob'ev, V. A.; Gorbunov, V. I.; Pokrovskii, A. V. (Tomsk Polytechnik Inst., USSR). Defektoskopiya, No. 1, 93-9 (1967). (In Russian).

The efficiency of 15, 25, and 30 MeV betatrons in steel defectoscopy was analyzed. A criterion was found for comparative studies of the GUP-Co-50 apparatus and the betatron efficiency based on the betatron radiography optimum focusing distances. The tests indicated betatron efficiency for radiographic control of 130- to 150-mm thick steel. (R.V.J.)

21335 OSCILLOGRAPHIC METHOD OF MEASURING ACCELERATING STRUCTURES. Loncar, Gojko (Czechoslovak Technical Univ., Prague). Jad. Energ., 12: 444-50(Dec. 1966). (In Czech).

In investigation of definite systems of high-frequency linear electron accelerators it is important to know the influence of the individual parts of the system on the transmitted and reflected power and on the form of the propagated wave. In such cases often qualitative knowledge suffices. Qualitative methods described in literature so far are of limited application. A more general qualitative method for investigating the interaction space of the waveguide type is described. An analysis of an oscilloscopic method of measurement of the accelerating structure of a complete system is given, a method which makes possible simultaneous evaluation of several mutually dependent parameters or any combination of them. In contrast to oscilloscopic methods heretofore which were applied only to the examination of homogenous sections the proposed method makes possible measurement also of nonhomogenous sections with side coupling apertures or models of such sections so modified. In accelerating structures composed of individual sections it is possible to locate unsuitable sections and indicate necessary corrections if deviations are not too great. The proposed method showed itself very advantageous in investigations of the form of coupling from waveguide to accelerating structure, so called wave-transformers. For example, in measuring the impedance for a given position or chosen shape of a door-knob transformer it is possible to determine immediately their influence on matching and thus on the transmitted and reflected energy. A comparison of the oscilloscopic waveforms on a two-beam oscilloscope at various points of the system can with experience in interpretation of the waveforms give instantly a great deal of information about the system and its operation which is of great advantage for operational adjustment at high energy levels. The described method was proposed and successfully used in bringing into running order the first Czechoslovak linear electron accelerator. On the basis of this new method it was possible for various experimental arrangements for each system configuration to produce proper adjustment in intervals of the order of tens of minutes. (auth)

21336 ENERGY AND MONOCHROMATICITY OF U-120 CYCLOTRON BEAM. Bem, Pavel; Habanec, Josef; Karban, Oldrich (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jad. Energ., 12: 450-2(Dec. 1966). (In Czech).

The proton beam behavior in a target chamber after leaving the cyclotron and passing through deflecting magnets and focusing lenses was studied at various parameters of cyclotron operation. The effects of the cyclotron magnetic field, the dee voltages, and the deflector voltages were investigated and the obtained data were used for determining the beam energy stability. (tr-auth)

21337 HIGH-FREQUENCY TRANSITIONS. Beurtey, R. (Service de Physique Nucleaire a Moyenne Energie, Saclay, France). pp 33-46 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Two advantages of using high-frequency transitions between Zeeman levels of atomic hydrogen or deuterium for the production of beams of polarized protons or deuterons are pointed out. The transitions allow the maximum polarization to be obtained by the adiabatic passage method, in which the entire population is transferred. Furthermore, it is easy to modulate the polarization parameter without perturbing the trajectories, either in the atomic beam or in the beam extracted from the machine. The general method is described, and the problem is reduced to a study of the mean value of some spin components, for which the associated magnetic moment interacts with a variable magnetic field. (L.B.S.)

21338 ACCELERATION OF POLARIZED PARTICLES. Powell, W. B. (Univ. of Birmingham, Eng.). pp 47-59 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Special factors involved in the acceleration of polarized particles are discussed in relation to AVF cyclotrons, referring particularly to recent experience obtained in accelerating polarized deuterons on the 40-inch cyclotron at Birmingham. These are methods of injection, matching the beam from the source to the accelerator, and depolarization effects during acceleration. The discussion is restricted to energies below about 100 MeV. (L.B.S.)

21339 SOURCES FOR POSITIVE POLARIZED IONS. Fleischmann, R. (Univ., Erlangen, Ger.). pp 21-32 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A description is given of atomic beam sources for the production of polarized protons, deuterons, and helium-3 particles. The main parts of the sources and their realization in different laboratories are described: dissociator, collimator, magnet, rf transitions, ionizer, vacuum, and detection of polarization. A survey is then given of the beam sources employed by the various laboratories. (L.B.S.)

21340 SOURCES OF POLARIZED NEGATIVE IONS FOR TANDEM ACCELERATORS. Haeberli, W. (Univ. of Wisconsin, Madison). pp 64-70 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966. (COO-7-0366).

A summary is presented of experimental investigations of the production and acceleration of polarized negative deuterium ions in the Wisconsin Tandem accelerator. Other methods which have been proposed to produce negative ions are briefly discussed. (L.B.S.)

21341 PRODUCTION OF H^- FROM H(2 s). Donnally, B.; Sawyer, W. (Lake Forest Coll., Ill.). pp 71-2 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Some results are reported of studies of production and ionization of metastable ions that are relevant to the design of a polarized particle source. (L.B.S.)

21342 RUTHERFORD LABORATORY POLARIZED PROTON SOURCE. Broad, D. A. G.; Banford, A. P.; Dickson, J. M. (Rutherford High Energy Lab., Chilton, Eng.). pp 76-8 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Improved electron bombardment ionizers for the Rutherford polarized proton source are described. The source is installed on a 50-MeV proton linear accelerator with a duty cycle of 1%.

The Mk II ionizer has yielded a 50-MeV current of up to 2×10^9 protons per second, 35% polarized. The best performance of the Mk III ionizer has been a 50-MeV beam of 1.3×10^8 protons per second, 51% polarized. (L.B.S.)

21343 CONSTRUCTION OF A POLARIZED PARTICLE SOURCE FOR APPLICATION TO THE ERLANGEN TANDEM ACCELERATOR. Clausnitzer, G.; Duerr, W.; Graw, G.; Salzborn, E.; Wilsch, H.; Witte, J. (Univ., Erlangen, Ger.). pp 79-80 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The source for polarized protons and deuterons for the Erlangen Tandem accelerator is described. Strong field separation and weak field ionization are used, which should give 50% proton polarization theoretically. (L.B.S.)

21344 CONSTRUCTION OF A POLARIZED PARTICLE SOURCE FOR THE APPLICATION TO A PRESSURIZED HIGH-VOLTAGE TERMINAL. Clausnitzer, G.; Henning, J.; Schatz, A. (Univ., Erlangen, Ger.). pp 81 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Preliminary measurements and operation of a source of polarized protons and deuterons under construction for use in the high-voltage terminal of a pressurized accelerator are briefly reported. (L.B.S.)

21345 PROBLEMS AND LIMITATIONS OF POLARIZED PARTICLE SOURCES FOLLOWING THE ATOMIC BEAM METHOD. Clausnitzer, G.; Graw, G.; Witte, J. (Univ., Erlangen, Ger.). pp 82-4 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Comments are made concerning upper limits for currents in two ionizer geometries, focusing properties of multipole and short sixpole magnets, and dimensions of the dissociative opening for production of polarized particles using the atomic beam method. (L.B.S.)

21346 DEUTERON BEAM INTENSITY AND POLARIZATION OBTAINED FROM A STRONG-FIELD IONIZER. Glavish, H. F.; Collins, E. R.; MacKinnon, B. A.; Walker, I. J. (Univ. of Auckland, N. Z.). pp 85-7 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A brief description is given of the strong-field analyzer of a polarized deuteron source, and of the detection arrangement for analyzing the tensor polarization in the beam. It is intended to locate the ionizer in the terminal of a Van de Graaff. (L.B.S.)

21347 POLARIZED ION SOURCE FOR THE ARGONNE TANDEM. von Ehrenstein, D.; Hess, D. C. (Argonne National Lab., Ill.). pp 88-90 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A brief description is given of the polarized hydrogen or deuterium ion source under construction for use on the Argonne Tandem Van de Graff. The source consists of a dissociator, inhomogeneous magnetic fields, adiabatic-transition regions, an ionizer, means for adjusting the polarization after ionization, and a charge exchanger to produce negative ions. (L.B.S.)

21348 SOURCE OF POLARIZED PROTONS FOR THE MILAN AVF CYCLOTRON. Candoni, B.; Luccio, A.; Merzagora, N.; Succi, C. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). pp 91-3 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The experimental results obtained with a source of polarized protons, which is being developed for eventual use in the Milan AVF cyclotron, are reported. The source employs a weak inhomogeneous magnetic field, produced by a sextupolar lens with zero longitudinal gradient. (L.B.S.)

21349 ATOMIC BEAM METHOD FOR PRODUCING A POLARIZED He^{3+} BEAM. Axen, D.; Craddock, M. K.; Erdman, K. L.; Klinger, W.; Warren, J. B. (Univ. of British Columbia, Vancouver). pp 94-6 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The design of a source of polarized $^{3+}$He ions involving an atomic beam source, a multipole separating magnet, and an electron bombardment analyzer is briefly described. The problem of separating the spin states is overcome by cooling the atomic beam source to 2.2°K. (L.B.S.)

21350 RADIO-FREQUENCY ION SOURCE APPLIED TO A POLARIZED ATOM BEAM. Heyman, M.; Delpierre, P.; Sene, R. (College de France, Paris). pp 97-100 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The beam compression technique was used in an attempt to increase the final output of ions by improving the ionization efficiency for a beam of polarized deuterium atoms. The polarized beam was mixed with a buffer gas in a pyrex bulb and ionized by rf excitation. The extracted ion beam containing deuterons was accelerated to 100 keV, and the neutron flux produced by the deuteron reaction in a tritium target was measured. The maximum flux was found to be 1.5×10^8 n/sec/4π, with a tensor component polarization $P_{33} = -0.10 \pm 0.01$. (L.B.S.)

21351 HIGH-FREQUENCY TRANSITIONS INDUCED BY THE ADIABATIC PASSAGE METHOD. Rudin, H.; Steiner, E.; Striebel, H. R. (Univ., Basel). pp 101-2 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Polarization measurements on a polarized deuteron atomic-beam source using high-frequency transitions are briefly reported. (L.B.S.)

21352 POLARIZATION OF NUCLEI IN SOLIDS. Jeffries, C. D. (Univ. of California, Berkeley). pp 105-12 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The dynamic polarization of protons in dipolar coupling with paramagnetic ions through saturation of forbidden microwave transitions is discussed. The method has been used in several successful polarized targets. Measurements of the proton polarization enhancement in LaMN (1% Nd) are shown for several values of the microwave attenuator. A proton spin refrigerator is also discussed in which the polarization is obtained by rotating a crystal in a magnetic field. (L.B.S.)

21353 POLARIZED TARGET FOR LOW-ENERGY PROTONS. Chapellier, M.; Garreta, D.; Kirsch, J. (CEN, Saclay, France). pp 126-7 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A description is given of a polarized proton target, which consists of a crystal of lanthanum magnesium nitrate cooled down to 1.15°K and polarized by the "solid effect" in a magnetic field of 18 kgauss using 70 kMc/sec microwaves. (L.B.S.)

21354 MEASUREMENT OF POLARIZATION OF A POLARIZED PROTON TARGET. Moretti, A.; Suwa, S.; Yokosawa, A. (Argonne National Lab., Ill.). pp 128-31 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A nuclear magnetic resonance detection system was developed to accurately determine the polarization of protons of a lanthanum (~1% Nd) magnesium nitrate crystal. The system produces two signals that can be used to determine the target polarization: the rf level, V, which is related to the rf susceptibility of the crystal, and its derivative, $dV/d\nu$, which is detected by a narrow band lock-in amplifier when the rf frequency is swept through the nuclear magnetic resonance frequency. Calculated results performed with a digital computer from the digitized NMR signals are presented. (L.B.S.)

21355 UCLA 45-MeV POLARIZED PROTON BEAM. Cahill, T. A.; Richardson, J. Reginald (Univ. of California, Los Angeles). pp 143-5 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The polarized proton beam of the UCLA sector-focused cyclotron is generated by means of elastic scattering from a thin carbon target located inside the vacuum tank in the internal proton beam. The calibration of the beam polarization and evaluation after a year of operation are discussed. (L.B.S.)

21356 STUDY OF THE DEPOLARIZATION OF A POLARIZED DEUTERIUM BEAM BY CHARGE EXCHANGE IN POTASSIUM VAPOR. Grueebler, W.; Koenig, V.; Marmier, P. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett., 24B: 335-6(Apr. 3, 1967).

The depolarization of a polarized beam of deuterium ions by charge exchange in potassium vapor was investigated as a function of the magnetic field present in the exchange region. (auth)

21357 INSTABILITY OF RESONATOR WALLS UNDER THE ACTION OF PONDERMOTIVE FORCES OF ELECTROMAGNETIC FIELD. Karliner, M. M.; Shapiro, V. E.; Shekhtman, I. A. Zh. Tekh. Fiz., 36: 2017-27(Nov. 1966). (In Russian).

Mechanical oscillations of resonator walls and voltage jumps during resonator readjustment under ponderomotive forces of electromagnetic fields acting inside of the resonator were studied. Stability conditions were found and instability thresholds were computed. (R.V.J.)

21358 STANFORD LINEAR ACCELERATOR: NEW MECCA FOR HIGH ENERGY PHYSICS. Davis, Harold L. Nucleonics, 24: No. 11, 48-53(Nov. 1966).

The expected competition of the SLAC with the AGS as a new-particle factory and as a producer of secondary-particle beams is discussed. Time scheduling and factors considered in project selection, operating status, and research programs scheduled for the first year of operation are also discussed. A brief description is included of the design and specifications. (L.B.S.)

21359 NEUTRON STUDIES IN SHIELDS AND TUNNELS OF THE 7 GeV PROTON SYNCHROTRON NIMROD. Shaw, K. B. (Rutherford High Energy Lab., Chilton, Eng.). pp 201-10 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

A problem common to both accelerator and reactor design is the transmission of neutrons along ducts and tunnels. Studies at other laboratories have been directed towards reactor safety, induced activity problems, and the effectiveness of heavily shielded structures against initial weapons radiation; the accelerator designer has little experimental information concerning the influence on tunnel transmission of the high energy neutron component. Measurements, through the shield of a high-energy accelerator, in a four-stage tunnel leading from a large source of secondary radiation are described. High-intensity beams are taken through the main accelerator shielding providing an additional problem of wall and end-stop shielding. The requirements for end-stop shielding are well known but the parameters for transverse shielding are not well documented. Measurements are reported on the neutron shielding properties of a hybrid arrangement of concrete and iron forming the wall shielding on an extracted proton beam line. Activation detectors were used in the measurements because of their advantages in high dose rate areas and in mixed radiation fields. Studies in the tunnel area indicate no significant effects of the high energy component in the latter stages and the tunnel transmission can be estimated using a simple semi-empirical relationship. The intermediate energy neutrons show an approximate exponential decrease with distance along the bent tunnel and the fast neutron population decreases more rapidly than the lower energy groups after the first tunnel stage. Estimates of attenuation length in wall shielding on an extracted beam line give a lower value than commonly used for high energy design, indicating a possible saving in the wall shielding for future extracted beams. (auth)

21360 ENERGY CONTROL OF A 140-MeV ELECTRON SYNCHROTRON BY THE INTEGRATOR METHOD. Pufahl, S.; Reich, H. (Physikalisch Technische Bundesanstalt, Brunswick). Z. Angew. Phys., 22: 230-5(1967). (In German).

The technical features of a system for the control of the operating energy of a 140 MeV-electron synchrotron with dc bias are described. The system is based on the principle of voltage integration and discrimination. It is believed that a long time stability of better than ±0.04% was obtained. (auth)

21361 INFLUENCE ON RELAXATION LENGTHS FOR HIGH ENERGY NEUTRONS OF THE ANGULAR DISTRIBUTION OF THE INCIDENT FLUX. O'Brien, K.; McLaughlin, J. E. (Atomic Energy Commission, New York). Nucl. Instrum. Methods, 51: 156-8(1967).

A theoretical investigation was made of high-energy neutron transmission through the transverse shield of the AGS. Starting from the one-dimensional transport equation, two second-order differential equations connecting the Legendre coefficients of the flux were obtained and solved using a semi-analytic method. Angular and energy distributions were calculated over the range of 500 to 0.63 MeV. The barrier was assumed to be 30% hydrogen and 70% aluminum to simulate soil containing 10% water by weight. It was found that the relaxation length λ is strongly dependent on the angular distribution of the incident flux. It is concluded that this explains a recent, apparently anomalous measurement in the transverse shielding of the AGS which leads to an unexpectedly low value for λ of about 90 g/cm^2. (L.B.S.)

21362 SHIELDING OF HIGH-ENERGY ELECTRONS: THE NEUTRON AND MUON COMPONENTS. Bathow, G.; Freytag, E.; Tesch, K. (DESY, Hamburg). Nucl. Instrum. Methods, 51: 56-60(1967).

Heavy concrete shielding measurements were extended to thicknesses from 200 to 400 cm using 4-GeV and 6-GeV electron beams. High-energy neutrons and secondary low-energy neutrons as well as muons were measured. Flux densities, attenuation coefficients, and lateral distributions are given. The experimental results agree with the estimates. (auth)

21363 TEN-CHANNEL SECONDARY EMISSION MONITOR. Piceni, H. A. L.; De Vries, C. (Instituut voor Kernphysik Onderzoek, Amsterdam). Nucl. Instrum. Methods, 51: 87-92 (1967).

To facilitate proper operation of a 60 MeV linear electron accelerator a grid-type secondary emission monitor was installed perpendicularly to the deflected beam for energy spectrum analyzing purposes. The monitor consists of ten aluminium strips in a geometry and location covering a 5% energy band. The ten strips are scanned with reed relays connected with an electrometer circuit. The energy spectrum is directly shown on an oscilloscope. The electronic equipment is discussed and a transfer function analysis of the electrometer circuit is presented. (auth)

21364 IMPROVEMENTS IN OR RELATING TO ION SOURCES. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,062,168. Mar. 15, 1967. Priority date Aug. 18, 1964, Netherlands.

An ion source is described which is comprised of an ion generation chamber, a grid-like electrode forming part of the chamber wall, and an extraction electrode external to the chamber for accelerating the ions in conjunction with the grid-like electrode. (B.G.D.)

21365 IMPROVEMENTS IN OR RELATING TO ION SOURCES. Nelson, Richard Stuart; Hill, Kenneth Jeffery (to United Kingdom Atomic Energy Authority). British Patent 1,064,101. Apr. 5, 1967. Filed July 13, 1964.

A sputtering ion source for producing an ion beam from a solid material is described. (B.G.D.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 21002, 21003, 21016, 21070, 21091, 21432, 21442, 21530, 21547, 21730, 21736, 21737, 21753, 21782, and 21784.

21366 (AD-646630) MEASUREMENT OF NEUTRON SPECTRUM, AGE, AND DIFFUSION LENGTH IN CONCRETE. Lim, M. Gene; Williamson, T. G.; Johnson, W. Reed (Virginia Univ., Charlottesville. Dept. of Nuclear Engineering). Jan. 1967. 39p. (NDL-TR-84) CFSTI $3.00 cy, $0.65 mn

Activation foil detectors were used to measure the fast-neutron spectrum, slowing-down age, and thermal-diffusion length in concrete. The neutron source was a uranium fission plate placed in the graphite thermal column of the University of Virginia Reactor. Experimental concrete slabs were placed in the concrete biological shield of the reactor so that the medium was essentially infinite in the lateral direction. Indium, magnesium, and aluminum threshold foils were used to map the fast flux; indium, gold, tungsten, and manganese resonance foils to measure the neutron age; and indium and gold foils to measure the thermal neutron distribution. The fast spectrum retains essentially the fission shape with a slight dip in the 3- to 5-MeV range. The measured ages are essentially the same, 149 cm^2 to the indium, gold, and tungsten resonances and 126 cm^2 to the manganese resonances. The thermal diffusion length was measured as 6.0 ± 0.5 cm. (auth)

21367 (CONF-650616-25) TRITIUM CONSIDERATIONS ASSOCIATED WITH THE OPERATION OF COCKCROFT-WALTON-TYPE NEUTRON GENERATORS. Johnson, Arthur G. (Division of Compliance (AEC), Berkeley, Calif. Region V). Apr. 29, 1965. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Health Physics Society Annual Meeting, Los Angeles, Calif.

A study was conducted to evaluate potential health and safety hazards associated with the release of tritium during operation of Cockcroft-Walton-type neutron generators. A brief review of operating characteristics of neutron generators employing tritium targets, and key physical and biological characteristics of tritium was included in order to clearly establish a basis for several significant problems. In this study, consideration was given to potential tritium hazards arising from the buildup of large quantities of tritium in electronic ion getter vacuum pumps, the accumulation of significant quantities of tritium in various mechanical and oil diffusion vacuum pumps, the presence of tritium contamination on certain portions of the accelerator system, the release of tritium to the environment through pump exhaust, the disposal of used pump oils and targets, the storage of unused accelerator targets, the difficulties encountered in detection of tritium, and the need for additional coverage of certain potential tritium hazards in neutron generator instruction manuals. (B.G.D.)

21368 (CSIR-FIS-12) ABSOLUTE CALIBRATION OF TWO AMERICIUM-BERYLLIUM NEUTRON SOURCES. Steyn, J.; Thilo, L. R.; De Jesus, A. S. M. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab.). Oct. 1965. 17p. Dep. mn.

The emission rates of two americium–beryllium neutron sources were measured by the manganous sulphate bath method and were found to be: 327 ± 0.066 × 10^6 neutrons per second for source NPRL N-1, which was supplied by The Radiochemical Centre, Amersham, and 1.614 ± 0.017 × 10^6 neutrons per second for source Am N-116 which was lent by the National Research Council, Ottawa, for intercomparison. Measurements made by the NRC and the NPRL on the emission rate of source Am N-116 agreed to within 1%. (auth)

21369 (IDO-17212) RAVEN: A COMPUTER PACKAGE FOR EVALUATING RESOLVED AND UNRESOLVED RESONANCE ABSORPTION INCLUDING PIN SHADOWING. Wheeler, F. J. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Feb. 1967. Contract AT(10-1)-205. 43p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A computer code, RAVEN, was prepared for the IBM-7040 to provide a fast, accurate, and convenient calculation of neutron resonance absorption in both the resolved and unresolved energy ranges. An option to compute the Dancoff correction for cylindrical pins in a lattice is included so that resonance integrals and multigroup cross sections may be obtained with only one run on the computer. FORTRAN IV is utilized throughout with the exception of one MAP subroutine, PSICHI, which computes the pointwise, Doppler-broadened cross sections. (auth)

21370 (K-1693) A USERS MANUAL FOR ANISN: A ONE DIMENSIONAL DISCRETE ORDINATES TRANSPORT CODE WITH ANISOTROPIC SCATTERING. Engle, Ward W. Jr. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Mar. 30, 1967. Contract W-7405-eng-26. 89p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The computer program ANISN is a FORTRAN IV (version 13) program which solves the one-dimensional Boltzmann transport equation for slab, cylindrical, or spherical geometry. As a secondary calculation, the detailed flux generated as the solution to the Boltzmann equation may be used to perform a group reduction of the cross sections. The user's manual describes in detail the format of the input data required to execute the many options available in the ANISN program. As an aid to understanding the data, the input and output of a sample problem are presented with comments. (auth)

21371 (RT-FI-(66)28) IL PROBLEMA DELLA VALUTAZIONE DEGLI SPETTRI NEUTRONICI IN PRESENZA DI PLUTONIO. (On the Problem of the Estimation of the Neutron Spectra in the Presence of Plutonium). Cardosi, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 17p. (In Italian). Dep. mn.

From a recent feasibility study on PCTR measurements with light-water-moderated plutonium-fueled lattices, the need arose of an experimental evaluation of the neutron spectrum in the presence of plutonium. The possibility of evaluating the neutron spectrum on the basis of few experimental quantities, such as activation ratios of detector foils having cross sections with different energy dependence, is investigated. Correlations between cross sections of various isotopes and detector foil cross section ratios are derived. (auth)

21372 (UNC-5157) UNC-SAM-2: A FORTRAN MONTE CARLO PROGRAM TREATING TIME-DEPENDENT NEUTRON AND PHOTON TRANSPORT THROUGH MATTER. Troubetzkoy, E. S. (United Nuclear Corp., Elmsford, N. Y.). Sept. 1966. Contract DA-30-069-AMC-785(X). 108p.

A description is given of the UNC-SAM-2 (United Nuclear Corporation Stochastic Approximation Method) Monte Carlo code for treating time-dependent neutron and photon transport through matter in complicated geometrical configurations. Some of the new importance-sampling and variance-reduction techniques which were incorporated into the code are discussed. (S.F.L.)

21373 VARIANCE OF CERTAIN FLUX ESTIMATORS USED IN MONTE CARLO CALCULATIONS. Clark, Francis H. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 27: 235-9(Feb. 1967). (ORNL-TM-1548).

Calculations were set up to determine the effect of the grazing flux on the surface-crossing flux estimator and the pillbox track-length estimator used in Monte Carlo calculations. It was found that grazing particles make only higher order contributions to current or flux but significantly increase the variance. These effects are more pronounced at internal surfaces than at external boundaries. The use of nonstochastic methods to estimate contributions of grazing particles is justified. (auth)

21374 ONE-VELOCITY NEUTRON TRANSPORT PROBLEMS BY THE TRANSFER MATRIX METHOD. Aronson, Raphael (New York Univ., N. Y.). Nucl. Sci. Eng., 27: 271-82(Feb. 1967).

The transfer matrix for the neutron flux in slab geometry is expressed analytically, along with a number of auxiliary quantities, for energy-independent interactions with isotropic scattering. The eigenvalues and eigenfunctions of the transfer matrix are readily expressed in terms of those introduced by Case, working directly with the Boltzmann equation. The results are applied to the albedo problem, the Milne problem, and the critical slab problem. Since the transfer-matrix approach works in principle for any cross sections, the ease of application implies that numerical calculations for more complicated cross sections will be reasonably straightforward. (auth)

21375 MEASUREMENTS AND CALCULATIONS OF THE SPECTRAL AND SPATIAL DETAILS OF THE FAST-NEUTRON FLUX IN WATER SHIELDS. Verbinski, V. V.; Bokhari, M. S.; Courtney, J. C.; Whitesides, G. E. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 27: 283-98(Feb. 1967). (ORNL-P-2637).

The spectral intensity of the fast-neutron flux penetrating a water medium was measured for two configurations: a large-source, poor-geometry arrangement; and a small-source, almost-good-geometry configuration. In the large-source experiment, the spectral intensity of the angular flux was obtained at six posi-

tions in the water shield of a pool-type reactor and for as many as three angles at each position. In addition to the measurements, the spectral shape and the absolute intensity of angular flux in the shield were calculated. In conjunction with this, the absolute neutron source density was mapped throughout the reactor volume and the distribution along the reactor center line was used as input to two neutron-transport calculations that were carried out for a one-dimensional, spherical geometry. In the small-source experiment, a 2-cm-thick lead target irradiated with short bursts of 33-MeV electrons provided a source of photoneutrons with approximately a fission spectrum at a distance of 40 cm from water slabs of various thicknessess. This distance, together with the large separation of slab and detector and a small-aperture collimator, approximated a good-geometry arrangement for measurements of neutrons leaking normally from the slab. Consequently, these leakage spectra were very sensitive to total neutron cross sections and a distinct peak was observed at 5 to 7.5 MeV. This peak was not at first reproduced by transport calculations that used the measured source spectrum as input; however, when the neutron total cross sections of oxygen were updated with relatively recent high-resolution data, the agreement both in spectral shape and in attenuation (the latter determined from sulfur-activation ratios) was noticeably improved. (auth)

21376 NEUTRON AIR-TRANSPORT DATA FOR THE DESIGN OF PROTECTIVE STRUCTURES. Karcher, R. H. (Holmes and Narver, Inc., Los Angeles, Calif.). Nucl. Sci. Eng., 27: 367-87 (Feb, 1967).

The transport of neutrons from a point source of simulated weapons radiation in infinite air is calculated. Weapons neutron spectra are simulated using a mixed source composed of a chopped fission spectrum with most of the neutrons below 0.4 MeV deleted, and an equivalent number distributed uniformly in the 12- to 16-MeV range. The results obtained are generally conservative, from a shielding standpoint for most nuclear devices. The method of track length stretching is used to improve the efficiency of the Monte Carlo analysis for deep penetration calculations. Well-converged fast-neutron flux and dose data are obtained for penetration distances of about 400 g/cm^2 (approximately 2 miles in sea-level air at 68°F). Energy spectra and angular distributions are calculated also; however, the convergence is less satisfactory in this case. It is found that the inelastic and capture gamma sources resulting from neutron interaction in air are of extremely low intensity and are probably negligible for most shielding applications. Integral and differential neutron air-transport data are tabulated as a function of penetration distance to facilitate their use in shielding calculations. (auth)

21377 FEW-GROUP AND MULTIGROUP CALCULATIONS OF NEUTRON PENETRATION. Shure, K. (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 27: 468-72(Feb, 1967).

Some P_3 few-group calculations of thermal-neutron flux distributions in water and in iron-water shields were compared with P_3 multigroup calculations. The energy-group structure of the few-group calculations was varied in an attempt to reproduce the multigroup results. (D.C.W.)

21378 EFFECT OF ANISOTROPIC SCATTERING IN PLANE-GEOMETRY TRANSPORT THEORY AND MONTE CARLO CALCULATIONS. Mendelson, M. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). Contract W-31-109-Eng.-52. Nucl. Sci. Eng., 28: 127-32(Apr. 1967). (TID-23053(Rev.)).

The sensitivity of three thermal-energy model problems to anisotropic scattering was investigated by comparing double P_5 solutions with P_3 and P_1 scattering expansions. Results indicate that P_3 scattering effects can be significant in the calculation of absorption rates of certain sensitive plane-geometry configurations. Monte Carlo calculations were also performed for one of these problems, using two different anisotropic scattering representations: the transport approximation; and a "histogram" kernel, which match the first two and four Legendre moments of the scattering kernel, respectively. The transport approximation was found to give discrepancies of eight to nine percent in thermal absorption rates, and it is concluded that this scattering representation can lead to serious errors in Monte Carlo calculations. (auth)

21379 SOLUTION OF GROUP-DIFFUSION EQUATION USING GREEN'S FUNCTION. Kobayashi, Keisuke; Nishihara, Hiroshi (Kyoto Univ.). Nucl. Sci. Eng., 28: 93-104(Apr. 1967).

The group-diffusion equation in one-dimensional geometry is solved by using Green's function. Using Green's tensor, the group-diffusion equation is transformed into a system of linear equations which contain only the fluxes at the interfaces between the regions. Solving this equation, the fluxes at the interfaces and the flux inside the regions are obtained with the aid of Green's tensor. This treatment is the same kind of approach as that of the response matrix method or the theory of invariant imbedding. The group-diffusion equation is then solved by the source iteration method. Using Green's function, the exact three-point difference equation is obtained; and the explicit forms for the slab, cylindrical, and spherical geometry are given. It is shown that the usual three-point difference equation is obtained if the source term is approximated to be flat piecewise and if Green's function is expanded into Taylor's series neglecting all but the first two terms. Sample calculations for a thermal and a fast reactor show that the improved difference equation obtained by approximating the source term by a polynomial of second degree is more accurate than the usual three-point difference equation. (auth)

21380 ANALOGY BETWEEN TIME-DEPENDENT DIFFUSION THEORY AND CLASSICAL MECHANICS. Clancy, B. E.; Tavel, M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 28: 105-10(Apr. 1967). (BNL-10274).

An analogy is set up between a theory of time-dependent neutron diffusion and the Lagrange theory of mechanical systems, by observing the similarity between Hamilton's principle and a well-known variational principle in diffusion theory. Recognition of the redundancy of certain variables makes it possible to proceed correctly to an equivalent Hamiltonian theory, and the analog of the canonical integral principle is then shown to be a modification of the original variational principle which permits the use of trial functions that have discontinuous time behavior. (auth)

21381 ANISOTROPIC SCATTERING COEFFICIENTS IN THE CONSTANT CROSS-SECTION TRANSPORT EQUATION. Murray, Raymond L.; Siewert, Charles E.; Harrington, Walter J. (North Carolina State Univ., Raleigh). Nucl. Sci. Eng., 28: 124-6(Apr. 1967).

The coefficients that enter the anisotropic scattering formulation of the constant cross-section transport equation are investigated. Exact expressions to order ten are presented as well as a useful, nested series for numerical calculations to any order. (auth)

21382 ASYMPTOTIC NEUTRON PULSE VELOCITY AND THE SYSTEM DISPERSION LAW. Moore, M. N. (San Fernando Valley State Coll., Northridge, Calif.). Nucl. Sci. Eng., 28: 152-4(Apr. 1967).

A method of calculating the asymptotic neutron pulse velocity from the dispersion law is outlined. (D.C.W.)

21383 LIMITATION OF THE ROUSSOPOULOS VARIATIONAL PRINCIPLE? Pomraning, G. C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 28: 150-2(Apr. 1967).

It is shown that, in the application of the Roussopoulos variational principle, for a certain class of trial functions the designation of the error term as a second-order term is questionable, leading to doubts about the usual interpretation of the variational procedure. (D.C.W.)

21384 NEUTRON SCATTERING BY LIQUID TERPHENYL. Goddard, A. J. H. (Imperial Coll. of Science and Tech., London). Brit. J. Appl. Phys., 18: 205-12(Feb. 1967).

Generalized frequency distributions for the normal modes of hydrogen motion in liquid Santowax-R (terphenyl) at 207 and 267°C were fitted to the phased-chopper velocity selector measurements of Brugge. The fitting procedure was based upon the method of Egelstaff and Schofield. It is shown that the hydrogen frequency distribution is similar to the equivalent distribution for the solid over the energy range 0.005 to 0.06 eV. There is a discrepancy of approximately 12% between the total cross section at 0.025 eV calculated from the fitted model and the direct measurements of Brugger. (auth)

21385 A MARKOV MATRIX TREATMENT OF NEUTRON DIFFUSION IN THIN SLABS. Eaton, M. L.; Huddleston, C. M. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Nucl. Sci. Eng., 27: 475-8(Feb. 1967).

A formation of neutron diffusion in thin slabs, using a Markov matrix method, is outlined. (D.C.W.)

21386 SOME RESULTS ON TRANSPORT THEORY AND THEIR APPLICATION TO MONTE CARLO METHODS. Spanier, Jerome (Bettis Atomic Power Lab., West Mifflin, Pa.). J. Math. Anal. Appl., 17: 549-59(Mar. 1967). (WAPD-T-1876).

A correspondence between a physical model based on the transport equation and a probability model is established. It is shown that if the physical model is subcritical, then the probability model corresponding to the analog case is also subcritical. (D.C.W.)

21387 APPLICATIONS OF PULSED NEUTRON MEASUREMENTS IN VERY LARGE SYSTEMS. Garlid, K. L. (Univ. of Washington, Seattle); Bierman, S. R. Nucl. Appl., 2: 440-7 (Oct. 1966). (BNWL-SA-510).

Pulsed neutron experiments in very large homogeneous systems are useful in estimating fundamental-mode decay constants even though it is impossible for an asymptotic mode ever to be completely established. Experimental results in water show that the observed decay of the neutron density is very nearly exponential and that the decay constant is close to the asymptotic value. A comparison of some relatively simple theoretical models illustrates the significance of fast neutron dispersion and the very poor prediction obtained, even qualitatively, using one-group time-dependent diffusion theory. (auth)

21388 PYROLYTIC GRAPHITE AS A SECOND ORDER NEUTRON FILTER. Bergsma, J.; Van Dijk, C. (Reactor Centrum Nederland, Petten, Netherlands). Nucl. Instrum. Methods, 51: 121-4(1967).

The total neutron cross section of pyrolytic graphite was determined at room temperature as well as at liquid nitrogen temperature in the energy range of 0.0015 to 0.200 eV by means of a Fermi chopper. It is demonstrated that the material is an excellent filter for removing the higher order contamination from a beam of neutrons which has its first order energy at approximately 0.005 eV and 0.013 eV. (auth)

21389 SCATTERING CROSS SECTION OF HYDROGEN IN WATER–DIOXANE SOLUTIONS. Suszkin, A. (Univ., Kiel). Atomkernergie, 11: 433-4(1966). (In German).

The scattering cross section of hydrogen in water–dioxane solutions was calculated from the values of the transmission, obtained for 13 solutions with varying water concentration and neutron energies between 0.578 and 0.024 eV. (auth)

21390 TRANSPLUTONICS: PROMISING NEUTRON SOURCES FOR RESEARCH. Stetson, Robert L. Nucleonics, 24: No. 11, 44-7; 75(Nov. 1966). (UCRL-14158(Rev.1)).

The use of the High Flux Isotope Reactor (HFIR) at ORNL for the production of transplutonic isotopes is discussed from both the technical and economic points of view. High neutron flux levels, equivalent to those available in the most powerful reactors, and with similar irradiation volumes, can be produced with gram quantities of these spontaneously fissioning isotopes. The properties of some of these isotopes (^{244}Cm, ^{248}Cm, ^{250}Cm, ^{250}Cf, ^{252}Cf, ^{254}Cf, and ^{256}Fm) which fission with neutron yields upwards of 2.8 per fission are discussed. (S.F.L.)

21391 THE NEUTRON SPECTRUM IN THE THERMAL FLUX DENSITY STANDARD AT THE NATIONAL RESEARCH COUNCIL, CANADA. Geiger, K. W. (National Research Council, Ottawa). pp 289-94 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

This standard is a rigid assembly consisting of a graphite and a polyethylene moderator in which are embedded six ^{241}Am–Be (α,n) sources. The subcadmium flux density is $nv_0 = 8700 \pm 130$ cm^{-2} sec^{-1}. The neutron temperature is 22°C above the moderator temperature. The epithermal flux spectrum does not follow the 1/E law but decreases less rapidly with energy. An epithermal flux index r′(E), analogous to the Westcott index r, is calculated, which varies with the resonance energy of an activated detector foil. Improvements in the geometry are suggested in the light of the results. However, since at present for most activations in the standard flux only cadmium ratio measurements are required, the epithermal spectrum is of little consequence. (auth)

21392 DESIGN AND CALIBRATION OF A THERMAL FLUX DENSITY STANDARD. Thompson, I. M. G. (Berkeley Nuclear Labs., Eng.). pp 311-17 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

A thermal flux density standard has been constructed to calibrate foils and other small detectors. The flux was determined from absolute measurements made with activated gold foils. The foils were activated in an air cavity 8 cm long by 5.5 cm in diameter, situated at the center of a graphite cube of 42 cm side. The graphite cube was surrounded by a polythene reflector and either four or six ^{241}Am/Be (α,n) sources can be placed at the centers of opposing faces of the graphite block. The flux density below cadmium cut-off, $n_{th}\,V_0$, was estimated to be 1.85×10^4 cm^{-2} sec^{-1} for the four-source arrangement, and 2.69×10^4 cm^{-2} sec^{-1} for the six-source arrangement. (auth)

21393 A CRITICAL COMPARISON OF THREE METHODS OF ABSOLUTE YIELD MEASUREMENTS FOR NEUTRON SOURCES. Yaritsina, I. A. (Mendeleev Inst. of Metrology, Leningrad). pp 318-21 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

Three independent methods for absolute measurement of the number of neutrons emitted by a source are described. Each of these methods can be used with success in one circumstance or another. By considering in detail each of the methods studied, their relative advantages are determined in order to select the most appropriate method for a particular problem. The methods of associated particles, manganese activation and gold foil activation comprise the three methods described. Each of these methods and the proper measuring equipment are described elsewhere and attention in this paper is mainly drawn to sources of error in each of the methods. (auth)

21394 DICE MARK V: A METHOD OF PREPARING NUCLEAR DATA IN A FORM SUITABLE FOR MONTE CARLO NEUTRONICS CALCULATIONS. Parker, J. B. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). pp 365-9 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

All Monte Carlo neutronics codes require the frequent, but systematic, consultation of what is generally a very sizable amount of nuclear data, which will consist of cross sections, angular distributions, energy spectra, etc. Different Monte Carlo codes have different geometrical features; for example axial or spherical symmetry may be exploited in the construction of a special-purpose code. The nuclear data handling is, however, independent of these geometrical considerations and there are therefore important advantages in having a single nuclear data processing system that can be used quickly and automatically for all Monte Carlo codes. The system described is the Atomic Weapons Research Establishment's solution to the nuclear data processing problem and is called the Dice system. The first component is a Nuclear Data Library tape, containing the information in a suitable form for subsequent use in Monte Carlo calculations. This is written by a routine called Mould which takes for input the content of the United Kingdom Atomic Energy Authority Nuclear Data Library and converts this into a suitable form. The main features are that cross sections are expressed as a function of energy in histogram form and that the whole mass of miscellaneous data is arranged in a hierarchical order corresponding to the actual sequence in which the data are used in the calculations. The next component of the Dice system is a routine called Absynth, which has as its object the allocation of that part of the Library tape germane to the particular problem being considered to core storage in a systematic manner. Absynth requires for input not only this tape but also a series of particulars about the materials (compositions, densities, etc.) in the problem. Once the data are allocated to core storage, the Monte Carlo calculation proceeds automatically. The main features of Mould and Absynth and other routines used in the Dice system are described and a review of the whole problem of synthesizing basic microscopic nuclear data for use in Monte Carlo codes is included. (auth)

21395 COMPLEMENTARY VARIATIONAL PRINCIPLES IN NEUTRON DIFFUSION THEORY. Arthurs, A. M. (Univ. of Wisconsin, Madison). Proc. Roy. Soc. (London), Ser. A, 298: 97-101(Mar. 28, 1967).

Complementary variational principles associated with neutron diffusion in solids are presented. The resulting formulas are used to derive new expressions which provide upper and lower bounds for the absorption probability. (auth)

21396 MAGNETIC MIRROR THERMAL NEUTRON POLARIZER. Petrascu, M.; Apostolescu, S.; Ionescu, D. R.; Marinescu, L. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 11: 601-6(1966).

An apparatus for the production of beams of polarized thermal neutrons by the reflection of a thermal neutron beam by a magnetized Co mirror is described. A well-collimated beam with a polarization of 92.5%, a neutron intensity of 9×10^6/sec, and a reflectivity of about 95% can be obtained. (D.C.W.)

21397 NOTE ON THE RESOLUTION FUNCTION IN PULSED-SOURCE NEUTRONS TIME-OF-FLIGHT MEASUREMENTS. Arcipiani, B. (CCR Euratom, Ispra, Italy). Energ. Nucl. (Milan), 14: 109-11(Feb. 1967).

A method is presented for the graphic determination of the properties of a non-Gaussian resolution function which is involved in neutron time-of-flight measurements. The technique has been applied to measurements of the time-of-flight distribution of neutrons emerging from a few geometrical arrangements of water at room and liquid-nitrogen temperatures after the injection of bursts of fast neutrons produced by means of a Van de Graaff accelerator. (S.F.L.)

21398 DETERMINATION OF THE FREQUENCY SPECTRUM IN SOLIDS BY INELASTIC SCATTERING OF COLD NEUTRONS. Kley, W. (EURATOM-CCR, Ispra, Italy). Z. Naturforsch., 21a: 1770-86(1966). (In German).

The various possibilities are examined how to measure the frequency distribution of solids by the inelastic scattering of thermal and subthermal neutrons. Particular attention is drawn on measuring-techniques that allow the determination of the frequency distribution even if the scattering cross section of the target material is not totally incoherent but a mixture of a coherent and an incoherent component. It is shown how the frequency distribution of solids can be measured even if the cross section is totally coherent by the use of a doping technique. Atoms as H and V, that have an almost entirely incoherent scattering cross section, are used as impurities in the solid of interest, serving as a probe of the host lattice vibrations. By studying the difference of the two independent inelastic scattering experiments, one with the pure, the other with the impure solid, it is possible to derive the frequency distribution function of the host lattice itself. Examples are given for vanadium and niobium. In addition, evidence is given how the best experimental conditions are selected for this type of inelastic neutron scattering experiments. (auth)

21399 SPATIAL AND ANGULAR DISTRIBUTION OF NEUTRONS FROM A POINT SOURCE. Veselov, V. M. pp 40-56 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The one-velocity problem of spatial and angular distribution of neutrons from an isotropic point source assumed to be located in an infinite homogeneous medium with total macroscopic cross section Σ_t and scattering cross section $\Sigma_s(\mu)$ expanded in a series with respect to Legendre polynomials $\Sigma_s(\mu) = \Sigma_{l=0}^{\infty}(2l + 1/4\pi)\,\sigma_l P_l(\mu)$, where $\sigma_l = 2\pi\int_{-1}^{1}\Sigma_s(\mu)P_l(\mu)d\mu$, is considered. Solutions for the resultant distribution functions are found and theoretical data calculated according to various formulas are compared. (ATD)

21400 NEUTRON TRANSFER IN NONMULTIPLYING SYSTEMS WITH SPHERICAL SYMMETRY. Germogenova, T. A.; Suvorov, A. P.; Utkin, V. A.; Bass, L. P. pp 57-66 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The literature on methods for solution of radiation transfer problems is briefly reviewed, and the problem of an isotropic point source is considered. Since the problem of an isotropic point source in an infinite medium has been studied in more detail in transfer theory than the case of a bounded medium, the solutions for these problems are compared on the basis of the one-velocity model with isotropic scattering for spheres with finite and infinite radii. A comparison of formulas describing the asymptotic behavior of the density of a finite sphere with a large radius shows that the results of calculations of the density of scattered radiation from a point source in an infinite homogeneous medium may be directly used for determining the density only when absorption is less than 1 everywhere except in the region adjacent to the boundary r = R. (ATD)

21401 ANGULAR DISTRIBUTIONS OF FAST NEUTRONS IN VARIOUS ENVIRONMENTS. Dulin, V. A.; Kazanskii, Yu. A. pp 72-3 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The angular energy distributions of fast neutrons under conditions of barrier geometry as a function of the atomic weight of the ambient medium, the thickness of the barrier, and the energy and shape of the neutron source are considered. For media which do not contain hydrogen, the angular distribution of the radiation within the solid angle $2\pi\sin\theta d\theta$ from an isotropic point source of neutrons with an energy of 3.4 MeV at angles of 20 to 70° is isotropic and practically independent of atomic weight and thickness of the medium (for a thickness of 1.5 to 5 times the mean free path) with an accuracy of 20 to 30%. As the energy of the neutron source is increased, the dosage in this solid angle begins to show angular anisotropy. Curves are given showing the angular distribution of fast neutrons with an energy above this threshold value. The results show that the angular distribution of fast neutrons for angles greater than 30° is independent of the form of the environment or its thickness and is not even affected by the energy and shape of the neutron source. The measurement error is less than 10%. It is possible that this conclusion will not be valid for a greater thickness and neutrons in the reactor spectrum. (ATD)

21402 EXPERIMENTAL STUDY OF THE PROPAGATION OF THERMAL NEUTRONS CLOSE TO THE SOURCE IN THE UNBOUNDED ATMOSPHERE. Degtyarev, S. F.; Kukhtevich, V. I.; Tarasov, V. V. pp 206-9 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The density of thermal neutrons is experimentally studied to provide data for computing capture γ radiation in air. A Po–Be fast neutron source was used in a paraffin block having walls 20 cm thick. Thermal neutrons are taken as those with an energy below the cadmium threshold, $E_n < 0.4$ MeV, and neutrons with greater energies are called fast neutrons. An SNM–0 boron counter was used for measuring the density of thermal neutrons. The source and detector were located at an altitude of 60 m to eliminate the effect of neutrons scattered from the earth. Three quantities were measured directly: the density of neutrons throughout the entire spectrum escaping from the paraffin block; the density of thermal neutrons formed from the fast neutrons; and the density of fast neutrons escaping from the source and propagated in the atmosphere. The results show that the fraction of thermal neutrons produced by attenuation in the atmosphere is small in comparison with the thermal neutrons for the given spectrum. A comparison of experimental and theoretical data for thermal neutron distribution shows excellent agreement as a source temperature of 293°K with some discrepancy when the source temperature is increased to 440°K. Experimental error is less than 6 to 10%. This discrepancy between experimental and theoretical data is not understood and requires further study. (ATD)

21403 SPATIAL DISTRIBUTION OF THE DOSE RATE FROM AN ISOTROPIC POINT SOURCE OF NEUTRONS IN THE ATMOSPHERE AND AT THE AIR–EARTH INTERFACE. Degtyarev, S. F.; Kukhtevich, V. I. pp 210-15 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Experimental results are given on the spatial distribution of relative dose rate for neutrons scattered in the unbounded atmosphere and at the air–earth interface from an isotropic point source with average initial spectral energies of 4.2 MeV (Po–Be source) and 1.9 MeV (Po–Be source in an iron sphere with a wall thickness of 6 cm). An isodose neutron dosimeter was used for neutron detection. The detector had a noticeable anisotropy and therefore the dose rates were measured at 3 mutually perpendicular positions of the detector and the results were averaged. The angles $\Delta\eta$ were determined experimentally and were 19, 25, 38, 48 and 58° for the Po–Be source and 10, 17, 23, 34, 44 and 54° for the 1.9 MeV source. The horizontal distance R was varied from 9.8 to 30.5 m and the height of the source H was adjustable from 1 to 50 m. It was found that an increase in the height H results in an increase in the relative dose rate up to ≈5 m followed by a smooth reduction in dose rate with an increase in height above this point. The dose rate as a function of distance R is approximately linear. An expression for the dose rate as a function of distance, height, and initial neutron energy when H is held constant is given. A table comparing experimental data for the dose rate with the results of the derived expression shows excellent agreement. A simple expression is given which may be used for practical calculations of the relative dose rate for initial neutron energies of less than 6 MeV. (ATD)

21404 SPACE–ENERGY FLUX DISTRIBUTION IN NEUTRON TRANSPORT THEORY. Boffi, V. C. (CNEN, Bologna). Nukleonik, 9: 97-110(Feb. 1967).

The exact step-by-step solution of the Boltzmann equation, governing the space-energy distribution of the scalar flux of neutrons slowed down by elastic collisions against stationary nuclei of an infinite medium in the case of plane symmetry, isotropic scattering, constant cross sections and localized monochromatic source, is recognized to be amenable to numerical evaluation. The asymptotic behaviour of the exact solution at small energies is then studied analytically by inferring first the asymptotic behavior of its Fourier integral with respect to the space variable and then transforming back the resulting expression by means of the saddle-point method. The same behavior is obtained if a Laplace transform with respect to a suitable energy variable is applied to the asymptotic Fourier integral of the sought solution. It is thus possible to realize that such behavior is contributed by the pole which the double L- and J-transform of the solution turns out to show in the J-plane. The double Mellin–Fourier integral associated with the pole is finally given an exact asymptotic series representation in terms of the energy variable. From this representation the connection between the transport and the age theory results can be clearly understood. Numerical results are reported to illustrate the analysis developed. (auth)

21405 COLLECTIVE EFFECTS AND ERGODICITY OF THE TRANSPORT EQUATION. Hejtmanek, Hans (Oesterreichische Hochschule, Vienna. Deutsche Atomforums, Kiel). Nukleonik, 9: 111(Feb. 1967).

The representation of the solution of the neutron transport equation as a semigroup of linear transformations is briefly discussed, including collective effects. The asymptotic behavior of the flow is considered using ergodic theory. (D.C.W.)

21406 SCATTERING OF LOW-ENERGY NEUTRONS IN A MONATOMIC GAS MODEL OF A MULTIPLYING SYSTEM. Blackshaw, George Lansing. Raleigh, N. C., North Carolina State of the Univ. of North Carolina, 1966. 238p.

Thesis.

The elastic scattering of low-energy neutrons by the nuclei of a monatomic gas, which have an isotropic Maxwellian velocity distribution, is examined in detail within the framework of classical physics. A unified mathematical treatment, which fully preserves the three-dimensional aspects of the scattering process, is employed to review the dynamics of the neutron-nuclear elastic collision and to derive a new form of the velocity scattering probability function. It is expected that the function presented will be extremely useful in solving velocity-dependent neutron transport problems at or near thermalization energies in media where a monatomic gas scattering model can be satisfactorily employed. Unique single-integral expressions, which are valid for any analytical or numerical representation of the microscopic scattering cross section, $\sigma_s(v_r)$, are developed for the velocity scattering kernel and its spherical harmonics moments. Similar single-integral relations are also obtained for the total scattering and absorption probabilities, with the latter function demonstrating the versatility of the unified treatment of low-energy neutron scattering by its extension to other classes of problems. In addition, an energy-dependent value of $\bar{\mu}_0$, the average cosine of the neutron scattering angle in the laboratory system, is derived for both isotropic and anisotropic scattering in the center-of-mass coordinate system. All general formulations of the scattering and absorption functions are tested either by explicitly evaluating them in closed form for certain analytical cross sections and comparing these solutions with known results, or by reducing them to case of negligible moderator temperature, i.e., no nuclear motion. (Dissertation Abstr.)

21407 EFFECT OF SAMPLE GEOMETRY ON DECAY CONSTANT MEASUREMENTS IN WATER USING THE PULSED NEUTRON TECHNIQUE. Freed, DeBow. Albuquerque, N. Mex., Univ. of New Mexico, 1966. 330p.

Thesis.

The pulsed neutron technique is used to measure decay constants at room temperature for cylinders of water having the same buckling value but different height-to-radius ratios. Experimental parameters are varied to cover a wide range. Two neutron sources are used, each with background less than 10^{-5} of peak pulse output. A different 400-channel time analyzer is employed with each source. Buckling values are computed using several values for extrapolation distances. Parametric studies are made involving pulse width, intensity, shielding arrangements, and source-detector positions. In order to isolate the influence of geometry on decay-constant measurements, emphasis is placed on control of experimental error and on data analysis procedures. Decay curves are followed for 4 to 5 decades. Decay constants are computed for each experimental run with data points weighted and unweighted and for several (up to 20) starting and ending times. This procedure identifies the true exponential portion of the decay curve from which the representative decay constant for the system is selected. The typical error in the decay constant is 0.3 percent. Measurements for each of three geometries are made at least twice for 14 buckling values in the range 0.09 cm^{-2} to 0.7 cm^{-2}. A total of 117 decay constant measurements is used to compute diffusion parameters for the three shapes. For each geometry, diffusion parameters are computed for several combinations of points, for orders of fit through fourth, and for data points weighted and unweighted. Computed parameters for second-order fits are given. The differences in decay constant measurements imply neutron lifetimes which vary only because of geometry. The differences are larger than expected from uncertainty in buckling due only to variation in extrapolation distance. The results indicate that buckling, as presently defined, is not entirely adequate to describe small nonmultiplying systems. (Dissertation Abstr.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 21448 and 21602.

21408 (ORNL-TM-1754) SOME PRELIMINARY CONSIDERATIONS TO THE NEUTRON ELECTRIC DIPOLE MOMENT EXPERIMENT AT ORNL; INCLUDING A SUMMARY OF SYMMETRY PRINCIPLES FOR ELEMENTARY PARTICLES. Dress, W. B. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 63p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A review of the discrete symmetries of particle physics is given, and some of the more important experiments establishing the violations of these symmetries are discussed. The need for a new measurement of the electric-dipole moment of the neutron is suggested. The neutron spectrum obtained from a bent neutron conducting tube as a function of various experimental parameters is described. The transition probability for a split-coil magnetic resonance spectrometer is derived; this probability is then averaged over the neutron spectrum obtained in the bent conducting tube. The design problems of the required electric and magnetic field are also considered in detail. (auth)

21409 DECREASE OF NEUTRON YIELD FROM TRITIUM TARGETS. Katsaurov, L. N.; Kuznetso, A. N. At. Energ. (USSR), 21: 390-2(Nov. 1966). (In Russian).

The decrease of the neutron yield in D-T reactions was calculated on the basis of a diffusion mechanism and was compared with experimental results. The experimental and theoretical results agreed well. (J.S.R.)

21410 NEUTRON CROSS SECTIONS OF HYDROGEN IN THE ENERGY RANGE 0.0001 eV TO 20 MeV. Horsley, A. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Data, Sect. A, 2: 243-62(Sept. 1966).

Theoretical and experimental data for the neutron cross sections of ^1H are surveyed and values recommended for total and partial cross sections in the energy range from 0.0001 eV to 20 MeV. Available experimental data are supplemented where necessary by estimates based on nuclear theory. Details of energy and angular dependence are given so that the data are complete for the purposes of neutronics calculations. (85 references.) (auth)

21411 EXPERIMENTAL EVIDENCE AGAINST THE EXISTENCE OF A BOUND STATE OF THREE NEUTRONS. Fuschini, E.; Maroni, C.; Uguzzoni, A.; Verondini, E.; Vitale, A. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cimento (10), 48B: 190-3(Mar. 11, 1967).

An experiment based on the $n + T \rightarrow p + 3n$ ($Q = -8.49$ MeV) reaction was designed to look for production of the trineutron. If the trineutron is produced with an observable cross section in this reaction, there should be a well-defined peak above the top of the continuous spectrum of the protons emitted. The proton spectra at 0° and 15° gives no evidence for a proton peak corresponding to 3n production with binding energy lower than 3 MeV. As a by product of this investigation the cross section for the T(n,t)n reaction was found to be (228 ± 4) mb/sr at 0° and (124 ± 1) mb/sr at 15° (laboratory angles). For the T(n,p)3n reaction, values of $d\sigma/d\Omega|_{\theta=0°} = (25 \pm 6)$ mb/sr (integrated between 3.5 and 6 MeV proton energy) and $d\sigma/d\Omega|_{\theta=15°} = (10 \pm 3)$ mb/sr (integrated between 3.5 and 5.74 MeV proton energy) were measured. (S.F.L.)

21412 STUDIES OF NUCLEAR REACTIONS USING POLARIZED ^3He TARGETS PREPARED BY OPTICAL PUMPING. Phillips, G. C. (Rice Univ., Houston, Tex.). pp 113-25 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Experiments using polarized ^3He targets are reported, which include $^4He-^3He$ elastic scattering and $^3He(d,p)^4He$ reactions. Other experiments in progress or planned are summarized: the $^3He(n,p)T$ reaction using polarized thermal neutrons, the elastic scattering of protons from ^3He, and the acceleration of polarized ^3He ion beams. (L.B.S.)

21413 FEW-NUCLEON PROBLEM: THE $n + {}^4He$ PROCESS, INCLUDING COUPLING TO THE $d + T$ PROCESS, IN THE 20-MeV REGION. de Facio, B.; Gammel, J. L. (Texas A and M Univ., College Station). pp 178-90 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A theoretical study of neutron reactions and scattering on ^4He is summarized. The many-channel optical-model formalism is outlined, and theoretical predictions are compared with experimental data. (D.C.W.)

21414 SPIN CORRELATION PARAMETERS IN PROTON-PROTON SCATTERING BETWEEN 10 AND 26 MeV. Catillon, P.; Chapellier, M.; Garreta, D.; Thirion, J. (CEN, Saclay, France). pp 293-4 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.;

Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Spin correlation parameters for p–p scattering between 10 and 26 MeV were obtained by measuring the cross sections for the scattering of polarized proton beams by a polarized target. (D.C.W.)

21415 MEASUREMENTS OF C_{NN} IN 140-MeV P–P SCATTERING USING A POLARIZED TARGET. Brogden, T. W. P.; Jarvis, O. N.; Orchard-Webb, J.; Wigan, M. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 298–300 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The spin correlation parameter in p–p scattering at 140 MeV was measured using a polarized target of hydrated lanthanum magnesium nitrate. Both scattered and recoil protons were recorded in coincidence using three counter telescopes for scattering angles of ±30° and 45°. (D.C.W.)

21416 RE-EVALUATION OF OLD VALUES AND REMEASUREMENT OF POLARIZATION IN P–P SCATTERING AT 140 MeV. Jarvis, O. N. (Atomic Energy Research Establishment, Harwell, Eng.); Rose, B.; Scanlon, J. P.; Eaton, G. H.; Cox, G. F.; van Zyl, C. P. pp 301-3 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The polarization of two proton beams obtained from a synchrocyclotron was measured as was the asymmetry in the elastic scattering of both polarized beams by Al at 10°. The polarization in p–p scattering at 140.5 MeV was measured using a liquid hydrogen target. (D.C.W.)

21417 PROTON–PROTON SCATTERING AT 600 MeV USING A POLARIZED TARGET. PRELIMINARY RESULTS. Coignet, G. (CEN, Orsay, France); Cronenberger, D.; Kuroda, K.; (and others). pp 304-7 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The polarization for p–p scattering at 600 MeV was measured using a polarized target. The spin correlation parameter was measured at 585 MeV using a polarized beam and a polarized target. (D.C.W.)

21418 MEASUREMENT OF THE DEPOLARIZATION IN N–P SCATTERING AT 2.6 MeV. Purser, F. O.; Sawers, J. R.; Walter, R. L. (Duke Univ., Durham, N. C.). pp 311-13 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Triple-scattering asymmetries were measured for neutron elastic scattering by hydrogen (polyethylene), Fe, and Zr using polarized neutrons from the $^{12}C(d,n)^{13}N$ reaction. The depolarization parameter for n–p scattering was obtained. (D.C.W.)

21419 PHASE SHIFTS AND POLARIZATION IN PROTON–ALPHA SCATTERING FROM 940 TO 3200 keV. Brown, L. (Carnegie Institution of Washington, Washington, D. C.); Haeberli, W.; Traechslin, W. pp 349-51 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A phase-shift analysis of cross-section and left-right asymmetry data for proton scattering by He at 0.94 to 3.20 MeV was performed. (D.C.W.)

21420 ANGULAR DISTRIBUTION OF THE $D(D,^3H)p$ REACTION WITH A POLARIZED DEUTERON BEAM. Fick, D.; Fleischmann, R.; Graw, G. (Univ., Erlangen, Ger.). pp 359-61 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The angular distribution of protons from the reaction D(d,He-3)p at 113 keV was measured using nuclear emulsions to detect the protons. The components of the polarization were investigated. (D.C.W.)

21421 PARITY CONSERVATION IN STRONG INTERACTIONS. Drake, C. W.; Bonar, D. C.; Headrick, R. D.; Hughes, V. W. (Yale Univ., New Haven). pp 362-4 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The parity nonconservation effects were examined in the $T(d,n)^4He$ reaction at 150 keV with polarized deuterons. An expression is written for the angular distribution of the neutron, which contains a sum over all parity violating terms. The experiment consisted of a measure of the neutron distribution with the counters centered at 0 and 180° with respect to the polarization axis. The results set an experimental limit for the ratio of a parity violating to a parity conserving amplitude. (L.B.S.)

21422 TENSOR AND VECTOR POLARIZATION IN 22-MeV DEUTERON SCATTERING ON PROTONS. Arvieux, J.; Beurtey, R.; Goudergues, J.; Lechaczinski, M.; Mayer, B.; Mikumo, T.; Papineau, A.; Thirion, J. (CEN, Saclay, France). pp 370-3 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The tensor and vector polarization of deuterons scattered by protons at angles of ~30 to 160° cms was investigated by detecting recoil protons from the CH_2 target in coincidence with the deuterons. (D.C.W.)

21423 ANALYZING POWER OF HELIUM FOR NEUTRONS. Hoop, B. Jr.; Barschall, H. H. (Univ. of Wisconsin, Madison). pp 463-5 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A set of phase shifts is proposed for neutron scattering by He. The results of some calculations of the analyzing power of He using the phase shifts are presented and are compared with other phase-shift calculations. (D.C.W.)

21424 POLARIZATION OF PROTONS SCATTERED BY HELIUM FROM 3 TO 30 MeV. Weitkamp, W. G.; Haeberli, W. (Univ. of Wisconsin, Madison). pp 484-6 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966. (COO-7-0367).

Measurements of polarization in p–α scattering were made at six laboratory scattering angles between 45 and 115° for proton energies from 17.5 to 27 MeV. A phase-shift analysis of the data was performed using other data to extend the analysis to higher and lower energies. (D.C.W.)

21425 POLARIZATION FOR THE PROTON–DEUTERON ELASTIC SCATTERING AT 155 AND 138 MeV AND SLIGHTLY INELASTIC SCATTERING AT 155 MeV. Kuroda, K.; Michalowicz, A.; Poulet, M. (Institut du Radium, Orsay, France). pp 496-8 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Measurements were made of polarization in elastic p–d scattering at 138 and 155 MeV and in slightly inelastic p–d scattering at 155 MeV. The experimental results were compared with theoretical predictions. (D.C.W.)

21426 POLARIZATION AND CROSS-SECTION MEASUREMENTS IN ELASTIC SCATTERING AT 150 AND 80 MeV AND THE OPTICAL POTENTIAL. Marty, N.; Geoffrion, B.; Rolland, C.; Tatischeff, B.; Willis, A. (Laboratoire Joliot-Curie, Orsay, France). pp 499-501 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Differential cross sections and polarizations were measured for proton elastic scattering by ^{209}Bi, ^{40}Ca, and ^{12}C at 150 MeV and by ^{209}Bi, ^{40}Ca, ^{12}C, ^{140}Ce, and ^6Li at 80 MeV. Preliminary fits to the data were made using optical potentials. (D.C.W.)

21427 ANGULAR DISTRIBUTION OF NEUTRON POLARIZATION FROM $^{11}B(p,n)^{11}C$ REACTION. Calboreanu, A.; Minzatu, I.; Salagean, O.; Ciocanel, A.; Molea, M.; Dumitrescu, R. (Inst. of Atomic Physics, Bucharest). pp 502-3 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The angular distribution of neutron polarization from the reaction $^{11}B(p,n)^{11}C$ at 5.4 MeV was measured. The polarization was also calculated using the compound–nucleus theory and assignments of 3^-, 1^+, and 3^- for the 5.10-, 5.47-, and 6.01-MeV resonances, respectively. The results show that the compound-nucleus mechanism is dominant and that the assignments are valid. (D.C.W.)

21428 VECTOR AND TENSOR POLARIZATION IN d–α SCATTERING. McIntyre, L. C.; Trier, A.; Haeberli, W. (Univ. of Wisconsin, Madison). pp 504–6 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966. (COO-7-0368).

The spin tensor moments of deuterons elastically scattered by ^4He were measured in the energy range of 2 to 9 MeV at laboratory scattering angles of 45, 60, 75, and 90°. A phase-shift

analysis was carried out using the measured tensor polarization parameters as well as differential cross-section data. Indirect measurements of the vector polarization were also made; the results were compared with theoretical predictions. (D.C.W.)

21429 POLARIZATION OF NEUTRONS FROM THE REACTION D(d,n)^{3}He FOR DEUTERON ENERGIES BELOW 120 keV. Haensgen, H.; Pose, H.; Schirmer, G.; Seeliger, D. (Technische Univ., Dresden). pp 512-13 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The polarization of neutrons from the reaction D(d,n)^{3}He was measured using a thick target of heavy ice and deuterons magnetically analyzed for eight energies from 57 to 117 keV. The neutron polarization was obtained by measuring the left-right asymmetry of elastic scattering from ^{12}C. (D.C.W.)

21430 POLARIZATION OF NEUTRONS FROM THE ^{7}Li(p,n)^{7*}Be (432 keV) REACTION. Morgan, G. L.; Hollandsworth, C. E.; Walter, R. L. (Duke Univ., Durham, N. C.). pp 523-5 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The polarization of neutrons from the ^{7}Li(p,n)^{7*}Be (432-keV) reaction was measured using a pulsed proton beam in conjunction with a He gas scintillator. The polarimeter consisted of a spin-precession solenoid and a high-pressure He gas scintillator positioned 1.1 m from the Li target. (D.C.W.)

21431 APPLICATION OF IMPULSE APPROXIMATION IN THE THEORY OF MULTIPLE SCATTERING OF NEUTRONS BY HYDROGEN MOLECULE. Atanassov, A.; Ivanov, K. (Teachers Training Inst., Plovdiv, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 19: 993-6(1966).

The exact solution of the problem of scattering of neutrons by hydrogen molecules reduces to the solution of a system of integral equations. In most cases, the solution of such systems involves considerable mathematical difficulties. This problem is solved by means of impulse approximations. The derivation of the probability of molecular transition from one state to another is reduced to the summing up of a series which can be graphically represented as a sum of diagrams. The proposed method is applicable to cases in which the conditions for the applicability of impulse approximations are fulfilled. (S.F.L.)

21432 NEUTRON FLUX MEASUREMENT OF A ^{2}H(d,n)^{3}He SOURCE. Naggiar, V. pp 295-302 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

A source of ^{2}H(d,n)^{3}He neutrons is formed by bombarding a target of deuterium, occluded in an aluminium foil, with 100 keV deuterons. A surface-barrier junction is used to detect ^{3}He particles from this reaction, as well as ^{3}H and ^{1}H particles from the reaction ^{2}H(d,p)^{3}H, in two distinct geometries at 90° and 150° to the beam. An aluminium screen, 150 μg cm^{-2} thick, placed between the target and the junction, is necessary to reduce the continuous background of small pulses attributable partly to Coulomb scattering of deuterons in the target. In the ^{3}He spectrum all unwanted pulses are eliminated, in recording, by arranging coincidence with neutrons detected by a hydrogenous scintillator. If the position of this detector is sufficiently close to the target to intercept all neutrons in coincidence, the ratio of coincidence to ^{3}He counts determines the efficiency of the detector. The measure of fluence by direct detection of neutrons, corrected by the estimation of neutrons scattered by the target support, differs by about 2% from measurements by the associated particle technique. The angular distribution of neutrons is measured between 0° and 150°. In a cylindrical chamber, within which the target was centrally disposed, a junction device was used to measure the angular distributions between 60° and 150° for the particles ^{3}He, ^{3}H and ^{1}H. The anisotropy factors defined in the center-of-mass system by the equation $[(d\sigma(\phi)/d\bar{\omega}) = (d\sigma/d\bar{\omega})\ (1/2\pi)\ (1 + A\cos^2\phi)]$ are given for each of these reactions. (auth)

21433 NEUTRON DEPOLARIZATION IN NEUTRON–PROTON SCATTERING AND NEUTRON POLARIZATION FROM THE D(d,n)^{3}He REACTION. Purser, Fred Olthus Jr. Durham, N. C., Duke Univ., 1966. 197p.

Thesis.

The depolarization undergone by a beam of polarized neutrons scattered from protons at a neutron energy 2.6 MeV was determined by measuring the polarization of the scattered neutrons by a subsequent scattering in a He polarimeter. The ^{12}C(d,n)^{13}N reaction served as the polarized neutron source for the experiment. Multiple scattering corrections to the data were obtained by means of a Monte Carlo analysis of multiple scattering within the polyethylene scatterer used. The measured value for the depolarization is compared to theoretical predictions based on effective range theory and found to be in excellent agreement. As a check on the method, the depolarization for neutrons scattered from the spin zero-nuclei Fe and Zr was also measured and was found to agree well with the theoretically expected values. The neutron polarization from the D(d,n)^{3}He reaction was measured for incident deuteron energies between 1.0 and 3.7 MeV. Four angular distributions were obtained at deuteron energies of 1.5, 1.9, 3.0, and 3.7 MeV. In the analysis of the results, an attempt was made to determine if effects due to the presence of the nucleon-nucleon spin-orbit force could be isolated. Though the results of the analysis tend to point to the presence of such a force, further theoretical and experimental work is indicated before a definite conclusion can be reached. (Dissertation Abstr.)

21434 PARITY CONSERVATION IN STRONG INTERACTIONS AND THE CONSTRUCTION OF A MORE EFFICIENT IONIZER. Headrick, Robert Dale. New Haven, Yale Univ., 1965. 165p.

Thesis.

A direct test for violation of parity conservation in the reaction T(d,n)^{4}He was made using the Yale polarized deuteron source. The incident 150-keV deuteron beam was polarized along a y-axis transverse to the direction of propagation, and 2 large-angle scintillators simultaneously counted neutrons along the positive and negative y-axis. Interference between parity-violating and -conserving components in the outgoing waves would result in a neutron distribution asymmetric along y, dependent on the beam-vector polarization. By changing the hyperfine-transition frequency in the source, the sign of the vector polarization of the deuteron beam was periodically reversed without changing the nuclear alignment, enabling elimination of instrumental asymmetries. As a check, the nuclear alignment of the beam was varied, and asymmetries of these counters with respect to a 3rd counter in the x-z plane were measured. The experimental limit obtained for the ratio F of parity-violating to parity-conserving amplitudes is $|\mathrm{Re}F| \lesssim 3.8 \times 10^{-3}$. The development of an efficient ionizer which uses space-charge potentials to extract the ions is described. The ionization efficiency of 1/400 for D atoms at 500°K is one of the highest achieved by a low-field ionizer. Proposed improvements should increase the ionization efficiency still further. (Dissertation Abstr.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 19718, 21182, 21426, 21508, 21531, 21588, 21607, and 21617.

21435 (CEA-R-2986) INTERACTIONS A DEUX CORPS DANS LA REACTION ^{9}Be(n,$\alpha\alpha$nn) A 14 MeV. II MESURE DES SECTIONS EFFICACES. (Two-Body Interactions in the Reaction ^{9}Be(n,$\alpha\alpha$nn) at 14 MeV. II. Cross-Section Measurements). Giorni, Alain (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov. 1966. 53p. (In French). Dep. mn.

Thesis.

Using a double time-of-flight spectrometer, the momenta $\vec{k}_1$ and $\vec{k}_2$ of neutrons from the ^{9}Be(n,nn)$\alpha\alpha$ reaction at 14 MeV were measured. After analysis of correction factors for the measurement of differential cross sections, we appraise the importance of the different interactions observed was appraised. The results are compared with those in the literature. (auth)

21436 (CONF-651154-2) CALCUL ET MESURE DE L'HELIUM PRODUIT PAR REACTIONS (n,2n) ET (n,α) DANS LE BERYLLIUM. (Calculation and Measurement of the Helium Produced by (n,2n) and (n,α) Reactions in Beryllium). Droulers, Y.; Pleyber, G.; Carteret, Y.; Lucas, R.; Bareau, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Oct. 25, 1965. 15p. (In French). Dep. mn.

From Symposium on Flux Measurements used in Connection with Irradiation Equipment in Research and Material Test Reactors, Grenoble, France.

The quantity of He formed under reactor irradiation was calculated and compared with experimentally measured values. The experimental techniques and methods of measurement are outlined. The results show that the effect of the neutron spectra on the formation of He in Be is not negligible. It must be considered in order to interpret the results obtained in various irradiation implacements in a reactor and in order to compare irradiations made in different reactors. A chart is given that makes it possible to determine the quantity of He formed for a given dose n/cm^2

distributed according to a given spectrum. Inversly a measurement of the He formed can be used to determine a neutron dose. The possibility of using Be as a fast neutron detector under conditions where classical activation detectors can not be used is examined. (J.S.R.)

21437 (JINR-P4-3177) FOTORASSHCHEPLENIE YADRA ^{15}N. (Photodisintegration of ^{15}N Nucleus). Zhusupov, M. A.; Karapetyan, V. V.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 10p. (In Russian). Dep. mn.

The cross section for the absorption of the dipole γ quanta by the ^{15}N nucleus was calculated in terms of a particle-hole approach taking into account the residual interaction of nucleons in the nucleus. The main maximum of a giant resonance is in the region of 22 to 24 MeV. The maximum appearing at E_γ = 35 MeV is due to 1s-nucleon excitation. A "Pigmy" resonance is in the region of 14 to 18 MeV. (auth)

21438 (LYCEN-6659) ETUDE DE LA REACTION $^{14}N(d,\alpha)^{12}C$ A 28.5 MeV. (Study of the Reaction $^{14}N(d,\alpha)^{12}C$ at 28.5 MeV). Vidal, Jean Louis (Lyon Univ. (France). Institut de Physique Nucleaire). Dec. 1966. 122p. (In French). Dep. mn.

Thesis.

Cross-section angular distributions for the reaction $^{14}N(d,\alpha)^{12}C$ induced by 28.5-MeV deuterons were studied. As the value of the cross sections was very low, the study was limited to $\theta_{lab} < 90°$ and only the first two transitions $^{14}N(d,\alpha)^{12}C_{ground}$ and $^{14}N(d,\alpha)^{12}C_{4.43}$ were observed. The corrections made necessary by the geometry of the beam, detection field, and the gaseous target were carried out. In order to apply the distorted-wave approximation method with a maximum efficiency, the elastic scatterings $^{14}N(d,d)^{14}N$ and $^{12}C(\alpha,\alpha)^{12}C$ were studied at 28.5 and 51 MeV, respectively. The determination of the cross sections in absolute value was difficult because of the absence of a current integrator. Nevertheless, the study of the scatterings Au(d,d)Au at 28.5 MeV and Au(α,α)Au at 51 MeV shows that the Coulomb scattering is quite preponderant at small angles, and the differental cross sections of these scatterings were calculated using the Rutherford law. The differental cross sections of $^{14}N(d,d)^{14}N$ and $^{12}C(\alpha,\alpha)^{12}C$ were deduced by using intermediary targets, of Au and polystyrene and of ammonia gas. The theoretical angular distributions were calculated by assuming a direct-interaction mechanism for the reaction $^{14}N(d,\alpha)^{12}C$. The pick-up mechanism gave an acceptable agreement for the reaction to the ground state of ^{12}C. For the transition to the 4.43-MeV state, both the pick-up mechanism and the knock-on mechanism gave satisfactory agreement. (tr-auth)

21439 (N-67-16629) VIRTUAL TRANSITIONS TO THE CONTINUUM IN ^{16}O. Beres, W. P. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Aug. 1966. 15p. (NASA-CR-81336; TR-611). CFSTI $3.00 cy, $0.65 mn.

The effect of the high-momentum components of the repulsive hard core are usually included in the energy-independent two-body interaction. Seldom considered, however, are the virtual transitions to low-lying continuum states. As a test case, the shifts of the negative parity levels of ^{16}O due to these low-momentum, off-the-energy-shell transitions of both neutrons and protons were calculated. Their contributions were found to be significantly large. (auth)

21440 (UCID-15095) REVISION OF 05R SUBROUTINE INELAS. Kane, W. E. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 1, 1967. Contract W-7405-eng-48. 43p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The 05R subroutine INELAS was revised to treat the $^{9}Be(n,2n)$ reaction uniquely. Certain restrictions on the handling of input data were modified, and provision was made for a tabular display of all input data in the 05R output listing. The collision models in the earlier version were not changed. (S.F.L.)

21441 (UCRL-50181) CALCULATION OF NEUTRON INELASTIC CROSS SECTIONS USING ELECTROMAGNETIC TRANSITION DATA. Lutz, Harry F.; Anderson, John D. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 14, 1967. Contract W-7405-eng-48. 51p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Neutron inelastic cross sections are calculated for the first $J^\pi = 2^+$ state of even-even nuclei from neon to plutonium in the energy region from 7 to 14 MeV. Angular distributions and integrated cross sections are presented. Application of these results to odd-even nuclei is discussed. (auth)

21442 MEASUREMENTS OF THE SPECTRA OF UNCOLLIDED FISSION NEUTRONS TRANSMITTED THROUGH THICK SAMPLES OF NITROGEN, OXYGEN, CARBON, AND LEAD: INVESTIGATION OF THE MINIMA IN TOTAL CROSS SECTIONS. Clifford, C. E.; Straker, E. A.; Muckenthaler, F. J.; Verbinski, V. V.; Freestone, R. M. Jr.; Henry, K. M.; Burrus, W. R. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 27: 299-307(Feb. 1967). (ORNL-TM-1656).

Minima in the total cross sections of nitrogen and oxygen were investigated by measuring the spectra of uncollided fission neutrons transmitted through thick samples of the elements and by comparing the results with calculated spectra based on total cross sections only. Good agreement between the measurements and calculations was obtained for oxygen when the cross sections evaluated by Slaggie and Reynolds were used and for nitrogen when the cross sections measured by Foster and Glasgow were used. Calculations with other evaluated cross sections for these elements resulted in significant differences and indicate a lack of detailed knowledge of the valleys in the cross-section data. Measurements made for carbon and lead were in good agreement with calculations, as was expected since the cross sections for these elements are well known. The technique used for the spectral measurements employed an NE-213 proton-recoil spectrometer of high sensitivity. (auth)

21443 A SHELL MODEL CALCULATION IN THE CONTINUUM FOR THE REACTION $^{15}N(n,n')^{15}N$. Ebenhoeh, W.; Gloeckle, W.; Huefner, J. (Univ., Heidelberg). Phys. Lett., Part B, 24: 361-3(Apr. 17, 1967).

A calculation is reported which yields total and differential elastic and inelastic cross sections and polarization, and the poles and residues (partial widths) of the scattering matrix. A method proposed by Weinberg is used. (auth)

21444 THE $2s_{\frac{1}{2}}$ COMPONENT IN THE GROUND STATES OF SOME NUCLEI IN THE $16 \leq A \leq 36$ REGION. Lawergren, B. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., Part B, 24: 395-6(Apr. 17, 1967).

The intensity of $l = 0$ components in the (d,p) reaction was measured at E_d = 10 MeV and $\theta = 2^0$ for a series of nuclei in the d-s shell. For each target, the sum of these components determined the neutron population of the $2s_{\frac{1}{2}}$ shell in the target ground state. (auth)

21445 THE NUCLEAR CLUSTER MODEL AND REDUCED MATRIX ELEMENTS IN ^{6}Li. Hansteen, J. M.; Wittern, H. W. (Univ., Tuebingen, Ger.). Phys. Lett., Part B, 24: 381-3(Apr. 17, 1967).

Inelastic electron scattering data on ^{6}Li support a tentative nuclear model interpretation, suggesting an alpha-deuteron cluster picture in the surface region, whereas deeper inside this nucleus a shell-model limit seems to provide a better approximation to the correct wave functions. (auth)

21446 ANGULAR MOMENTUM PROJECTION ON HARTREE-FOCK WAVE FUNCTIONS FOR ^{8}Be AND ^{12}C. Lamme, H. A.; Boeker, E. (Vrije Univ., Amsterdam). Phys. Lett., Part B, 24: 367-8(Apr. 17, 1967).

Rotational bands are projected from intrinsic Hartree-Fock states. The agreement with the observed level structure is good for ^{8}Be, but bad for ^{12}C. (auth)

21447 EFFECTIVE-RANGE THEORY AND THE GROUND STATE OF ^{8}Be. Kermode, M. W. (Univ. of Liverpool). Phys. Lett., Part B, 24: 357-8(Apr. 17, 1967).

A width of 6.14 ± 0.04 eV for the ^{8}Be ground state is obtained from an effective-range analysis of the s-wave phase shift for α-α scattering. (auth)

21448 INVESTIGATION OF 12-MeV DEUTERON POLARIZATION. Dore, J. C.; Griffith, J. A. R.; Roman, S. (Univ. of Birmingham, Eng.). pp 60-3 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The asymmetries were measured in the elastic scattering of polarized deuterons by helium, berylilium and carbon in an attempt to select a suitable target for the use as a deuteron polarization monitor. Large asymmetries were observed in the scattering of deuterons by carbon at conveniently small angles. It was possible to monitor the polarization of the beam under various operating conditions of the polarized deuteron source of the Radial Ridge cyclotron. The value of the vector component of the deuteron polarization was estimated from the scattering of deuterons by helium using the known predictions of a phase-shift analysis. (auth)

21449 ABOUT THE POSSIBLE USE OF THE CARBON RECOIL DETECTION METHOD FOR NEUTRON POLARIZATION EXPERIMENTS. Grin, G. A. (Univ., Lausanne, Switzerland). pp 155-6 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A brief report is presented of part of an experiment aimed

at studying the $^{12}C(n; n,3\alpha)$ reactions induced by 14.1 MeV neutrons, using an improved time-of-flight technique. The experiment proved a possibility of detecting carbon recoils of an energy as low as 0.3 MeV, with an efficiency approaching 100%. Some information was also obtained concerning the discriminations which could be useful for an application to polarization measurements with dT neutrons. (L.B.S.)

21450 PROTON–NUCLEUS TRIPLE SCATTERING MEASUREMENTS AT 140 MeV. Jarvis, O. N.; Rose, B.; Taylor, A. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 308-10 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Some proton triple scattering measurements on ^{9}Be, ^{10}B, and ^{12}C at 140 MeV are discussed in which an attempt was made to observe spin-dependent effects that would require extra terms in the scattering matrix. Evidence for a spin-dependent effect was obtained. (D.C.W.)

21451 POLARIZATION IN THE SCATTERING OF 20- TO 30-MeV PROTONS BY CARBON. Craig, R. M.; Dore, J. C.; Greenlees, G. W.; Lowe, J.; Watson, D. L. (Univ. of Birmingham, Eng.). pp 319-21 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Measurements were made of polarization in the elastic and inelastic scattering of protons by C at 20 to 28 MeV. The results were compared with theoretical predictions using an optical-model potential and a complex potential with a real part of the Saxon-Woods form, an imaginary part of Saxon-Woods derivative form, and a spin-orbit term of the Thomas form. (D.C.W.)

21452 STRONG-COUPLING ANALYSIS OF PROTON SCATTERING AND POLARIZATION AT 30 AND 50 MeV. Craig, R. M.; Dore, J. C.; Lowe, J.; Watson, D. L. (Univ. of Birmingham, Eng.). pp 322-4 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Measurements were made of polarizations and cross sections for the scattering of polarized protons by C and Si at 30 and 50 MeV. The scattering from the ground states and the first excited states of C (4.43 MeV, 2^+) and Si (1.78 MeV, 2^+) were analyzed using the coupled-channels method. (D.C.W.)

21453 ELASTIC SCATTERING OF 21-MeV POLARIZED PROTONS BY COMPLEX NUCLEI. Bercaw, R. W.; Boschitz, E. T.; Vincent, J. S. (Lewis Research Center, Cleveland). pp 334-5 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Angular distributions of the polarization in the elastic scattering of 21-MeV polarized protons by 15 nuclei with A = 12 to 206 were measured between 15 and 165°. An optical-model analysis of the data was performed. (D.C.W.)

21454 DEUTERON ASYMMETRIES FOR 4 STATES EXCITED IN THE $^{12}C(p,d)^{11}C$ REACTION WITH POLARIZED PROTONS. Chant, N. S.; Fisher, P. S. (Oxford Univ.). pp 356-8 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Deuteron asymmetries in $^{12}C(p,d)^{11}C$ reactions at 30 MeV to the ground state and the first three excited states of ^{11}C were measured using polarized protons. A preliminary DWBA analysis of the data was performed. (D.C.W.)

21455 THE $^{6}Li(d,n)^{7}Be$ REACTION WITH POLARIZED DEUTERONS AT ENERGIES OF 270, 500, AND 600 keV. Michel, G.; Schier, W.; Benenson, R. E.; Huber, P.; Striebel, H. R. (Univ., Basel). pp 365-7 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The tensor polarization in the $^{6}Li(d,n)^{7*}Be$ reaction was measured directly, and the vector polarization was obtained from measurements of right-left asymmetries. Information on the orbital angular momenta of the neutron and the proton and the total orbital angular momentum transfer was obtained. (D.C.W.)

21456 THE $^{6}Li(d,\alpha)^{4}He$ REACTION WITH 600-keV POLARIZED DEUTERONS. Baumgartner, E.; Buergisser, H.; Michel, G.; Seiler, F.; Striebel, H. R. (Univ., Basel). pp 368-9 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The sensitivity of the $^{6}Li(d,\alpha)^{4}He$ to deuteron polarization was investigated at 600 keV. The results indicate that the reaction could be suitable as an analyzer for tensor polarization. (D.C.W.)

21457 POLARIZATION OF 4.4-MeV NEUTRONS SCATTERED ELASTICALLY FROM ^{6}Li AND ^{7}Li. Steuer, M. F.; Kelsey, C. A. (Univ. of Wisconsin, Madison). pp 466-7 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The angular distributions of the polarization of neutrons scattered elastically by ^{6}Li and ^{7}Li at 4.4 MeV were measured. The results indicate that the previously reported similarity of the angular distributions of the polarizations for ^{6}Li and ^{7}Li from 1 to 2 MeV is also present at 4.4 MeV. (D.C.W.)

21458 DOUBLE SCATTERING OF 1,7- TO 2,3-MeV PROTONS ON ^{12}C. Basile, R.; Durand, J.-L.; Tellez, A. (Nuclear Inst., Algiers). pp 487-8 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The polarization of protons elastically scattered by ^{12}C at 1.7 to 2.3 MeV was measured. A phase-shift analysis of the data was performed; the phase shifts were compared with phase shifts calculated on the basis of cross-section measurements. (D.C.W.)

21459 POLARIZATION OF PROTONS FROM $^{12}C(p,p)^{12}C$ ON AND NEAR THE 9.14-MeV ANOMALY. Terrell, G. E.; Jahns, M. F.; Kostoff, M. R.; Bernstein, E. M. (Univ. of Texas, Austin). pp 489-91 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Polarizations were measured as a function of energy at a laboratory angle of 47.5° from 8.6 to 9.6 MeV and at an angle of 130° from 8.8 to 10.0 MeV. Polarization and cross-section angular distributions were measured at 8.9, 9.15, and 9.6 MeV. A preliminary phase-shift analysis of the latter data was made. (D.C.W.)

21460 POLARIZATION OF NEUTRONS FROM THE $^{12}C(d,n)^{13}N$ REACTION FOR 2,0- TO 4,0-MeV DEUTERONS. Sawers, J. R.; Purser, F. O.; Walter, R. L. (Duke Univ., Durham, N. C.). pp 517-19 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Differential cross sections and polarization angular distributions for the reaction $^{12}C(d,n)^{13}N$ were measured for several deuteron energies between 2.0 and 4.0 MeV. (D.C.W.)

21461 CROSS SECTION OF THE $^{11}B(n,p)^{11}Be$ REACTION FOR 14.7 TO 16.9 MeV NEUTRONS. Stepancic, Bogdan Z.; Stanojevic, Dimitrije M.; Popic, Relja V.; Aleksic, Miodrag R. Bull. Boris Kidrich Inst. Nucl. Sci., 17: 237-9(July 1966).

The cross section of the reaction $^{11}B(n,p)^{11}Be$ was measured over the energy range from 14.7 to 16.9 MeV using an activation method. (D.C.W.)

21462 The ΛΛ HYPERNUCLEI $^{\ 6}_{\Lambda\Lambda}He$ AND $^{10}_{\Lambda\Lambda}Be$ AND THE Λ–Λ AND Λ–N INTERACTIONS. Ali, S. (International Centre for Theoretical Physics, Trieste, Italy); Bodmer, A. R. Phys. Lett., 24B: 343-6(Apr. 3, 1967).

The ΛΛ hypernuclei $^{\ 6}_{\Lambda\Lambda}He$ and $^{10}_{\Lambda\Lambda}Be$ are analyzed with various Λ–Λ potentials and with two different ranges for the Λ–N potential. Values of coupling constants are obtained from the Λ–Λ potentials; in particular, values of $g^2_{\Lambda\Lambda\sigma}$ are obtained which are compatible with the values of $g^2_{\Lambda\Lambda\sigma}$ obtained from the N–N data. (auth)

21463 MULTIPLE SCATTERING OF CHARGED PARTICLES. Marion, J. B.; Zimmerman, B. A. (California Inst. of Tech., Pasadena). Contract Nonr-220(47). Nucl. Instrum. Methods, 51: 93-101(1967).

Numerical calculations were carried out for the multiple scattering of charged particles as described by the theories of Molière and of Nigam, Sundaresan and Wu (NSW). The NSW theory is the more accurate but the deviations from the older theory of Molière are not great. An approximation to the NSW theory is given which is shown to be essentially indistinguishable from the complete NSW theory for the scattering of medium energy protons and which allows the construction of "universal" angular distribution curves. A method is given which permits the rapid evaluation of the angle at which the angular distribution has decreased to 1/e of its value in the forward direction. (auth)

21464 THE $^{15}N(d,\alpha_0)^{13}C$ REACTION AT DEUTERON ENERGIES OF ABOUT 1 MeV. Stanojevic, Dimitrije M.; Boreli, Fedor M. Bull. Boris Kidrich Inst. Nucl. Sci., 17: 161-7(July 1966).

The angular distributions of the ground-state alpha group from the $^{15}N(d,\alpha)^{13}C$ reaction at three deuteron energies, ranging from

1.0 to 1.2 MeV, were measured. The observed angular distributions do not show symmetry around 90°, particularly at 1.2 MeV. The experimental data were analyzed in terms of Legendre polynomials, and at 1.2 MeV angular distribution curves are calculated for the pick-up and knock-out processes. (auth)

21465 DIFFRACTION INTERACTION OF LIGHT NUCLEI. Sitenko, A. G.; Ismatov, E.; Tartakovskii, V. K. (Inst. of Physics, Kiev). Yadern. Fiz., 5: 573-82(Mar. 1967). (In Russian).

The diffraction interaction of weakly bounded cluster light nuclei with nuclei is considered. General formulas for elastic scattering and diffraction spallation amplitudes and expressions for integral cross sections dependent on the cluster mass ratio are obtained. The dependence of integral cross sections on the correlation between the radius of the weakly bounded nucleus and the range of the interaction is found. Angular distributions of ^{6}Li nuclei elastically scattered by ^{12}C and the deuteron angular distribution from the ^{6}Li spallation are determined. The comparison with the experimental data shows that the diffraction approach makes it possible to explain the absolute value of the observed spallation cross section and the properties of the angular distributions at the elastic scattering and at the spallation. It is investigated in what manner the magnitude of the cross section is influenced by the choice of the relative cluster motion wave functions and by the antisymmetrization of the total incident nucleus wave function. (auth)

21466 DIFFERENTIAL CROSS SECTIONS FOR THE REACTIONS $^{16}O(t,\alpha)^{15}N$ AND $^{16}O(t,p)^{18}O$ AT ENERGIES FROM 0.6 TO 1.75 MeV. Kobzev, A. P.; Gromov, A. V.; Kashlik, K.; Nedvedyuk, K.; Salatskii, V. I.; Telezhnikov, S. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 510-13(Mar. 1967). (In Russian).

Differential cross sections for the reactions $^{16}O(t,\alpha_0)^{15}N$, $^{16}O(t,\alpha_{1+2})^{15*}N$, $^{16}O(t,p_0)^{18}O$, and $^{16}O(t,p_1)^{18*}O$ were measured from 0.6 to 1.75 MeV at a laboratory angle of 90°. Yield curves for these reactions have a composite structure with many resonances. Possible levels of the compound nucleus ^{19}F corresponding to these resonances are given. (auth)

21467 PHOTODISINTEGRATION OF ^{7}Li WITH EMISSION OF PROTONS, DEUTERONS, AND TRITONS. Denisov, V. P.; Kulchitskii, L. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 5: 490-7(Mar. 1967). (In Russian).

The total γ-absorption cross section of ^{7}Li is estimated. For this purpose the cross sections for proton, deuteron, and triton photoproduction were measured, and the available data on the photoneutron emission were used. It is shown that at the excitation energies ~30–40 MeV the ^{7}Li nucleus decays into p + t + t with high intensity. The integral cross section of the total absorption up to 52 MeV is found to be 123 MeV · mbarn. (auth)

21468 PHOTODISINTEGRATION OF ^{6}Li. Denisov, V. P.; Komar, A. P.; Kulchitskii, L. A.; Makhnovskii, E. D. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 5: 498-503 (Mar. 1967). (In Russian).

The cross section of the photoproton production on ^{6}Li is determined using the proton spectra measured at $E_{\gamma\,max} = 30$ MeV with counter telescopes and the proton yield curves in the energy range 30 to 55 MeV. The cross sections of the deuteron and triton productions are found also at high γ-quanta energies (higher than 30 MeV). The total γ-absorption cross section of ^{6}Li as a sum over partial cross sections of various reactions is found to be 80 ± 12 MeV · mbarn in the energy range up to 55 MeV. The comparison with the sum rule calculations of the integral $\int [\sigma(E_\gamma)/E_\gamma]dE_\gamma$ allows one to determine the mean squared radius $\overline{R}_c^2$ of the charge distribution in the ^{6}Li nucleus as well as in the ^{4}He-p-shell associations. A reasonable agreement is obtained between the $\overline{R}_c$ value for the ^{4}He association in ^{6}Li and that from the data on the fast electron scattering by the ^{4}He nucleus. (auth)

21469 MEASUREMENT OF NEUTRON SPECTRA BY MEANS OF THE ^{6}Li(n,t)^{4}He REACTION. Beets, C.; de Leeuw, S.; de Leeuw-Gierts, G. (Commissariat a l'Energie Atomique, Cadarache, France). pp 124-39 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

There is interest in the determination of the spectra of fast neutrons above a few keV on the basis of the measurement of ^{6}Li(n,t)^{4}He reaction parameters. Recent physical data are reviewed, and the essential characteristics of the various responses are described. Experimental results are given (the spectrum measured being the spectrum at equilibrium in natural uranium), and the state of development of a calibrating device for the parameter ψ (the angle between the reaction products) is described. (auth)

21470 CROSS SECTIONS FOR PHOTONEUTRON REACTIONS ON ^{7}Li. Bazhanov, E. B.; Komar, A. P.; Kulikov, A. V. (Physical-Technical Inst., Leningrad). Dokl. Akad. Nauk SSSR, 171: 549-51(Nov. 21, 1966). (In Russian).

Cross sections of photo neutron reactions on ^{7}Li at energies from the (γ,n) reaction threshold $E_\gamma = 7.25$ MeV to 50 MeV were studied using a 4.5 g/cm thick lithium target with ~99% Li. A table of energy magnitudes assigned previously to ^{7}Li excitation levels for (γ,n), (γ,p), and (γ,t) reactions is discussed. Approximate calculations indicated the presence of ^{7}Li excitation states at energies from 10 to 15, 18 to 24, and 25 to 30 MeV. Thus, it is shown that the correlation between the theoretical and experimental data seems to be premature. (R.V.J.)

21471 ANGULAR CORRELATION MEASUREMENTS IN THE ^{9}Be(d,pγ)^{10}Be REACTION. Farouk, M. A.; Comsan, M. N. H.; El-Behay, A. Z.; El-Kamhawy, A. A.; Lvov, A. N.; Popov, A. I. (Atomic Energy Establishment, Cairo). Z. Phys., 201: 52-8(1967).

The p–γ angular correlations in the ^{9}Be(d, p, γ)^{10}Be reaction were measured in the reaction plane at $E_d = 1.3$, 1.5, 1.9, 2.3 and 2.45 MeV for proton angles $\vartheta_p = 35$, 80, and 120°. The anisotropy of the angular correlations measured for $\vartheta_p = 35°$ is independent of deuteron energy. A systematic shift of the symmetry axis from the recoil direction was observed. The shift is 20.5° at $E_d = 2.45$ MeV. The anisotropy decreases with increasing proton angle and vanishes at $\vartheta_p = 120°$. (auth)

21472 NEW ISOTOPE OF HELIUM: ^{7}He. Stokes, Richard H.; Young, P. G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 18: 611-13(Apr. 10, 1967).

Energy spectra were measured at 15 scattering angles for ^{3}He ions arising from the triton bombardment of ^{7}Li. A peak which appeared in the spectra at all scattering angles is attributed to the ground state of ^{7}He. The Q value of the reaction ^{7}Li(t, ^{3}He)^{7}He corresponds to ^{7}He being unbound to neutron decay by 0.42 ± 0.06 MeV. The width of the state was determined to be 0.17 ± 0.04 MeV. (auth)

21473 ROLE OF GIANT RESONANCES IN WEAK AND ELECTROMAGNETIC NUCLEAR EXCITATIONS. Ueberall, H. (Catholic Univ. of America, Washington, D. C.). Nuovo Cimento, Suppl. (1), 4: 781-809(1966).

The interrelation of giant-resonance excitations with other electromagnetic and weak excitations is demonstrated by muon capture. It is shown that due to the isospin dependence and to the particular structure of the weak and electromagnetic matrix elements, a variety of different states may be excited in neighboring nuclei. This permits a study of the giant resonances by electrons, muons, and photons, the results of which should mutually complement each other and thus lead to a more complete understanding of the giant-resonance states. The analysis was carried out by the predominant use of the Goldhaber-Teller model of the giant dipole state and its spin wave generalization. Results of the calculations are applied to several light-weight nuclei, e.g., ^{4}He, ^{12}C, ^{16}O, and ^{40}Ca. (S.F.L.)

21474 ENERGY AND SPATIAL DISTRIBUTION OF A STREAM OF SECONDARY NEUTRONS PRODUCED BY 660-MeV PROTONS IN BLOCKS OF GRAPHITE AND NICKEL. Kon'shin, V. A.; Matusevich, E. S.; Prokhorov, S. S. pp 226-35 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The spatial and energy distribution of neutrons in thick (i.e., comparable with the ionization path of the primary 660-MeV protons) blocks of graphite and nickel were observed following bombardment by 660-MeV protons. The neutrons in the blocks were produced by interaction of a monodirectional point beam of protons with the block material. The following indicators were used for measuring the spatial and energy distribution of the neutrons produced by reactions between the protons and the nuclei of the target: ^{115}In(n,γ)^{116}In; ^{238}U(n,γ)^{239}U; ^{63}Cu(n,γ)^{64}Cu; ^{27}Al(n,α)^{24}Na; ^{31}P(n,p)^{31}Si; ^{24}Mg(n,p)^{24}Na; ^{12}C(n,2n)^{11}C and ^{12}C(p,pn)^{11}C. The efficiency of β-radiation was determined for each indicator as a basis for finding the absolute number of captures. The number of captures per gram weight of the indicators (In, U, Cu, Al, Mg, P) was measured and normalized to a single incident proton. The measurements were made with respect to radius r with center on the axis of symmetry of the proton beam. Curves are given showing the number of captures N as a function of r for indium, phosphorous, magnesium, and aluminum indicators in nickel. The number of captures A from a plane monodirectional source of protons is determined by integrating the function N(r) with respect to target area; i.e., $A = 2\pi\int_0^\infty N(r)rdr$. Figures are given showing A as a function of distance from the forward face of the nickel block for In, P, Al, Mg, U, and Cu. Figures are also given for a graphite block showing N(r)r as a function of thickness Z for indium and phosphorous indicators. Curves are given showing the number of captures from a plane monodirectional source as a function of the distance Z from the

forward wall of a graphite block 120 cm thick for all indicators except carbon. Tables are given showing the neutron fluxes in various energy regions for both graphite and nickel. The neutron intensities are graphed as a function of thickness for both materials and it is shown that neutrons with energies below 4.65 keV are predominantly responsible for the neutron flux in graphite. A graphite block 120 cm thick shows a ratio of neutrons below this energy to those above of about 3.5 along the axis of symmetry. This ratio is 0.3 for a nickel block which is apparently due to the large absorption cross section in nickel at low neutron energies. Graphite and nickel show a difference in neutron fluxes below 4.65 keV by a factor of 30 while they differ by a factor of only 3 for neutron energies above 4.65 keV. The spatial distribution of the neutrons has a maximum at half the thickness of the block with symmetric distribution in graphite. The asymmetric distribution in nickel is due to the effect of neutron production by the primary beam. The energy spectrum is softer in graphite than in nickel. Graphite shows a considerable neutron leakage for the energy group below 10^{-6} MeV. (ATD)

21475 CALCULATION OF THE FLUX OF SECONDARY NEUTRONS PRODUCED BY 660-MeV PROTONS IN A GRAPHITE BLOCK 120 cm THICK. Kon'shin, V. A. pp 236-8 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Expressions are derived for calculating the neutron yield from a graphite block with a thickness equal to the ionization path of a 660-MeV primary proton and infinite dimensions in the other two directions. The results show a neutron flux of 0.22 neutrons/cm^2 sec per incident proton. The yield of tertiary neutrons produced by cascade neutrons at the rear face of the graphite block was calculated assuming that the energy of the tertiary neutrons is $^2/_3$ that of the cascade neutrons and that the number of secondary particles produced by bombardment of the carbon nucleus with protons is the same as for bombardment by neutrons. Calculations on these assumptions showed a flux of tertiary neutrons escaping through the rear face of the block equal to 0.03 neutrons/cm^2 sec per incident proton. The cascade protons produced by primary protons do not escape through the rear face of the block due to energy losses through ionization, although they may initiate a nuclear cascade process by interaction with carbon nuclei. The flux of neutrons emitted by this process through the rear face of the block is 0.05 neutrons/cm^2 sec per incident proton. The evaporative neutron flux is calculated assuming that the number of evaporative neutrons of evaporative neutrons is independent of the energy of the incident proton and is equal to 1.5. Calculations based on this assumption give 0.2 neutrons/cm^2 sec per incident proton escaping at the rear face of the block. It is pointed out that the theoretical numbers of neutrons and protons emitted in an elementary event during the interaction of high-energy protons are considerably dependent on the nuclear model which is used, particularly the nucleon density distribution. (ATD)

21476 (p,t) AND (p,d) REACTIONS IN LIGHT NUCLEI. Reynolds, Glenn Myron. Minneapolis, Univ. of Minnesota, 1966. 120p.

Thesis.

An investigation was made of the (p,t) reaction in ^{27}Al, ^{26}Mg, ^{23}Na, ^{19}F, ^{18}O, and ^{11}B and of the (p,d) reaction in ^{26}Mg and ^{28}Mg. The 40-MeV beam of the University of Minnesota Linear Proton Accelerator was used. Product particles were detected by an array of 32 solid state detectors in the focal plane of a 1 meter double focusing magnetic spectrometer. Overall energy resolution was about 170 keV FWHM for the deuterons and 230 keV for the tritons. Energy spectra to about 7 or 8 MeV excitation and angular distributions of the resolved levels were obtained in all the nuclei. Results of the (p,t) reaction in the deformed mass 24 region agree with the Nilsson scheme in that the ground state rotational band in the residual nuclei are preferentially excited. In ^{19}F and ^{18}O there is qualitative agreement with current ideas of particle-hole excitations in these nuclei. A DWBA analysis was made of the (p,d) results in the magnesium isotopes. The resultant spectroscopic factors in the case of the ^{24}Mg ground state band are in much better agreement with rotational model predictions if the effective binding procedure is used for the neutron form factor instead of the usual separation energy. No empirical evidence was seen of j-dependence in the (p,d) angular distributions. (Dissertation Abstr.)

21477 STUDY OF (d,^{6}Li) REACTIONS ON LIGHT AND INTERMEDIATE-WEIGHT NUCLEI. Slee, Frederick Watford. Seattle, Univ. of Washington, 1966. 103p.

Thesis.

The (d,^{6}Li) reactions on light and intermediate weight nuclei were studied using 21-MeV incident deuterons. The reactions studied were ^{12}C(d,^{6}Li)^{8}Be, ^{16}O(d,^{6}Li)^{12}C, ^{19}F(d,^{6}Li)^{15}N, ^{24}Mg(d,^{6}Li)^{20}Ne, ^{32}S(d,^{6}Li)^{28}Si, ^{40}Ca(d,^{6}Li)^{36}Ar, and ^{58}Ni(d,^{6}Li)^{54}Fe. Angular distributions and total cross sections were obtained. From the nature of these angular distributions, it was concluded that these reactions proceed by a direct pickup reaction mechanism. DWBA calculations were performed and were compared with the experimental data for several of these reactions. A semi-classical model of the reaction mechanism which offers a qualitative explanation of certain features of the experimental results is proposed. (Dissertation Abstr.)

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Refer also to abstracts 21192, 21416, 21418, 21426, 21433, 21444, 21441, 21452, 21453, 21463, 21473, 21474, 21476, 21477, 21531, 21607, 21610, 21612, and 21617.

21478 (AD-641115) EXCITATION OF ^{31}P AND ^{32}S BY 180 DEGREE ELECTRON SCATTERING. Kossanyi-Demay, P.; Vanpraet, G. J. (Stanford Univ., Calif. High-Energy Physics Lab.). Aug. 1966. Contract Nonr-225(67). 23p. (HEPL-394(Rev.)). CFSTI $3.00 cy, $0.65 mn.

A measurement was made of the differential cross sections for inelastic scattering of 50-MeV electrons at 180° by ^{31}P and ^{32}S nuclei. Using the long-wavelength approximation, lower limits for radiation widths were derived for the levels. For ^{32}S, the giant dipole resonance was investigated; and the results were compared with a recent calculation of B. M. Spicer. (auth)

21479 (CEA-R-3147) SECTIONS EFFICACES DIFFERENTIELLES ELASTIQUES ET INELASTIQUES OBTENUES PAR DIFFUSION DE PARTICULES α DE 44 MeV SUR DES CIBLES DE Mg, Ca, Ti Cr, Fe, Ni, Cu, Zn, Sn, ET Pb AU CYCLOTRON A ENERGIE FIXE DE SACLAY. (Differential Elastic and Inelastic Cross Sections Obtained by Scattering of 44-MeV α Particles on Targets of Mg, Ca, Ti, Cr, Fe, Ni, Cu, Zn, Sn, and Pb Using the Saclay Fixed-Energy Cyclotron). Bruge, Gaston (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1967. 39p. (In French). Dep. mn.

The results of some measurements of alpha differential elastic and inelastic scattering cross sections at 44 MeV using enriched targets of Ca, Cr, Cu, Fe, Pb, Mg, Ni, Sn, Ti, and Zn are tabulated. (D.C.W.)

21480 (KFK-510) MESSUNG UND INTERPRETATION DER TIEFLIEGENDEN, NACH DER REAKTION ^{73}Gd(n,γ)^{74}Ge ANGEREGTEN ZUSTAENDE VON ^{74}Ge. (Measurement and Interpretation of the Low-Lying States of ^{74}Ge Excited by the Reaction ^{73}Ge(n,γ)^{74}Ge). Weitkamp, C. (Kernforschungsanlage, Karlsruhe (West Germany). Institut fuer Angewandte Kernphhsik). Jan. 1967. 47p. (In German).

Thermal neutrons from the FR-2 reactor were monochromized by Bragg reflection from a lead single crystal and were captured in enriched ^{73}Ge to investigate the level structure of ^{74}Ge. Precision singles spectra measurements were performed over the whole energy range using two Ge(Li) detectors of 4.0 cm^2 by 0.5 cm and 2.7 cm^2 by 0.2 cm, respectively. Double and triple coincidence relations could be established with NaI(Tl) spectrometers, with the data processed by the Karlsruhe MIDAS System. A total of 148 gamma transitions were observed. A level scheme of ^{74}Ge is proposed involving 42 excited states between 0 and 4.6 MeV. An attempt is made to interpret the low-lying levels in terms of different collective models. The neutron binding energy of ^{74}Ge is determined to be 10202 ± 10 keV. (auth)

21481 (USNRDL-TR-67-21) STRUCTURE IN THE TOTAL ^{24}Mg(n,p), ^{27}Al(n,p), AND ^{27}Al(n,α) CROSS SECTIONS FROM 12 TO 15 MeV. Ferguson, J. M.; Albergotti, J. C. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 15, 1967. 30p.

The relative cross sections of the ^{24}Mg(n,p), ^{27}Al(n,p), and ^{27}Al(n,α) reactions were measured with accuracies of a few per cent or better. All three excitation functions fluctuate with periods of the order of a few hundred kilovolts and magnitudes of a few per cent. The observed structure is consistent with the Ericson theory. (auth)

21482 (NSJ-tr-64) SCATTERING OF ALPHA PARTICLES BY MEDIUM-WEIGHT NUCLEI. Kumabe, Isao; Ogata, Hiroshi; Tomita, Shigeharu; Inoue, Makoto; Okuma, Yasuhiko; Matoba, Masaru; Nomaguchi, Tamotsu. Translated from Genshikaku Kenkyu, 9: 726-31(1965). 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The angular distributions of the elastic and inelastic scattering of 34.4-MeV alpha particles by ^{58}Ni, ^{60}Ni, ^{90}Zr, ^{91}Zr, ^{92}Zr, ^{116}Sn, ^{117}Sn, ^{118}Sn, ^{119}Sn, and ^{120}Sn were measured using a broad-range magnetic analyzer with array detectors and/or of a semiconduc-

tor detector. For ^{58}Ni and ^{60}Ni, it was found that the angular distribution of inelastic scattering leading to the two-phonon 4^+ state has an intermediate phase between the elastic distribution and the first 2^+ inelastic distribution, and the angular distribution of inelastic scattering leading to the two-photon 0^+ state in ^{60}Ni is out of phase with the two-phonon 4^+ inelastic distribution. On the other hand, the inelastic distribution of the two-phonon 2^+ state is in phase with the corresponding elastic distribution, and the inelastic distribution to the three-phonon 2^+ state is out of phase with the elastic distribution. The angular distribution of inelastic scattering leading to the 5^- state in ^{90}Zr was obtained. The differential cross sections are considerably large and the oscillation period is somewhat longer than the period for the elastic scattering. For Sn isotopes, the angular distributions for the quadrupole and octupole excitations were obtained for both even-even nuclei and odd-mass nuclei. Optical-model analysis and distorted-wave calculations are in process. (auth)

21483 MEASUREMENT OF ASYMMETRY COEFFICIENTS OF $\beta-\gamma$ CIRCULAR POLARIZATION CORRELATION IN ALLOWED β-TRANSITIONS. Behrens, H. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Z. Phys., 201: 153-71(1967). (In German).

The asymmetry coefficient of the β-circularly-polarized γ-correlation of allowed β-decays has been measured for several nuclides with high accuracy. The polarimeter was a new type in which the magnet is used as Compton-scatterer and as β-spectrometer at the same time with the advantage that one has four coincidence possibilities between two γ- and two β-counters. The results of measurements on the following nuclides are given: ^{24}Na, ^{41}Ar, ^{46}Sc, ^{47}Ca, ^{48}V, ^{52}Mn, ^{56}Co, ^{58}Co, ^{110m}Ag, and ^{134}Cs. Fermi matrix elements are determined from the values on these nuclei and their physical implications are discussed. (auth)

21484 INELASTIC SCATTERING AND RADIATIVE CAPTURE OF PROTONS BY ^{50}Cr AND ^{54}Cr. Abuzeid, M. A.; El-Zaiki, M. I.; Mansour, N. A.; Popov, A. I.; Saad, H. R.; Storizhko, V. E. (Atomic Energy Establishment, Cairo). Z. Phys., 199: 506-17 (1967).

Total yields and angular distributions of gamma rays following the inelastic scattering of protons from ^{50}Cr and ^{54}Cr were measured at proton energies below 2.5 MeV. Gamma ray spectra resulting from the proton radiative capture by ^{50}Cr and ^{54}Cr were obtained. Transitions from most of the ^{51}Mn and ^{55}Mn low-lying levels were observed. The experimental results are in good agreement with predictions of the statistical compound nucleus theory. (auth)

21485 BROKEN SYMMETRIES IN QUANTUM FIELD THEORY. Fabri, E. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy); Picasso, L. E.; Strocchi, F. Nuovo Cimento (10), 48A: 376-85(Mar. 21, 1967).

Approximate or "broken" symmetries are discussed in the framework of axiomatic field theory. A previous result is generalized to space-time symmetries: i.e., that a nonexact symmetry cannot be implemented by a time-dependent unitary operator. It is shown that this has nothing to do with the well-known difficulties of defining a charge, which exist also for exact symmetries. A further results is that if a symmetry is not exact, there is at least one observable whose VEV is maximally noninvariant. (auth)

21486 ELEMENTARY AND COMPOSITE PARTICLES IN FIELD THEORY. I. Alexanian, M. (Univ. of California, Livermore); Zimmerman, R. L. Nuovo Cimento (10), 48A: 386-411(Mar. 21, 1967). (UCRL-14808-T).

The formal meaning of composite particles and fields is studied in the context of field theory. A composite field can be given a well-defined meaning but this need not be the case for particles. The connection between fields, particles, compositeness and the vanishing of the renormalization constants is illustrated by means of a modified form of the Zachariasen model which has a pole in its vertex function. It is shown that the vanishing of the particle's renormalization constants has nothing to do with the particle being composite. In fact, it is sometimes superfluous to speak of the particle as being composite. Compositeness is only well defined for the fields. The fields can be made composite by the vanishing of the quantities z_{ij} which are the generalized wave function renormalization constants of the fields. The vanishing of the vertex renormalization constant has nothing to do with compositeness in this model. (auth)

21487 YIELD OF ^{22}Na PRODUCED IN NUCLEAR REACTIONS IN CYCLOTRON. Krasnov, N. N.; Dmitriev, P. P. At. Energ. (USSR), 21: 400-1(Nov. 1966). (In Russian).

The yield of ^{22}Na produced by Mg + d and Mg + p reactions in a cyclotron was determined and was compared with the yield from other nuclear reactions reported elsewhere. The results showed that the most effective method for the production of ^{22}Na is the irradiation of magnesium with deuterons. (J.S.R.)

21488 TWO-PARTICLE, ONE-HOLE STATES OF ^{41}K AND THE ^{39}K(t,p)^{41}K REACTION. Pellegrini, F. (Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cimento (10), 48B: 155-8 (Mar. 11, 1967).

The eigenvalues and eigenfunctions of the 2p-1h, $(1f_{\frac{7}{2}})^2(d_{\frac{3}{2}})^{-1}$ states in ^{41}K were theoretically determined, and the excitation intensities were calculated for the ^{39}K(t,p)^{41}K reaction. (S.F.L.)

21489 LEVELS IN ^{33}P. Currie, W. M.; Evans, J. E. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., Part B, 24: 399-400(Apr. 17, 1967).

By means of the reaction ^{30}Si(α,p)^{33}P, excited states were found in ^{33}P at 1.43, 1.81, and 2.42 MeV. (auth)

21490 INELASTIC ELECTRON SCATTERING IN ^{32}S. Hill, L. L. (Naval Ordnance Lab., Silver Spring, Md.); Ueberall, H. Phys. Lett., Part B, 24: 364-6(Apr. 17, 1967).

The E1 and M2 matrix elements for inelastic electron scattering and photoexcitation of the giant resonance states in ^{32}S are presented. A sequence of dominant levels similar to those in ^{12}C is found but at generally lower energies. In particular, the 2^- spin-flip state which should rise up for large momentum transfers, lies here at 13.5 MeV. (auth)

21491 FINE-STRUCTURE ANALYSIS OF ANALOG RESONANCES IN ^{41}K. Mekjian, A.; MacDonald, W. (Univ. of Maryland, College Park). Contract AT(40-1)-3491. Phys. Rev. Lett., 18: 706-9(Apr. 24, 1967).

An analysis of the fine structure observed in a high-resolution study of analog resonances in ^{41}K using proton elastic scattering by ^{40}Ar was performed using a K-matrix theory of fine structure in nuclear reactions. (D.C.W.)

21492 CHARACTERISTICS OF GIANT RESONANCE OF SILICON ISOTOPES. Cherdantsev, P. A.; Kozlova, G. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 3, 35-9(1966). (In Russian).

The giant-resonance characteristics of ^{28}Si and ^{30}Si are calculated using the model developed for this purpose by V. V. Balashov. The wave function describing the collective state of the nucleus is constructed by applying the dipole moment operator to the ground-state function, and the zero approximation of the single-particle levels is determined directly from experimental data on the levels of neighboring nuclei. The energy of the maximum of the giant resonance, the energy width of the resonance, and the integral absorption cross section are all calculated by means of Balashov's procedure. Level schemes are presented for ^{28}Si and ^{30}Si, and tables of the configuration and the neutron and the proton excitation energies are given for the first five levels. The corresponding transition energies are calculated. The characteristics of the giant resonance for photodisintegration calculated for ^{28}Si agree with experiment. (ATD)

21493 ELASTIC SCATTERING FROM ^{40}Ca AS A SOURCE OF POLARIZED PROTONS FOR SCATTERING EXPERIMENTS. van der Woude, A.; Blumberg, L. N.; Gross, E. E.; Zucker, A. (Oak Ridge National Lab., Tenn.). pp 140-2 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The use of ^{40}Ca as a polarizer of protons is described. The arrangement used at ORIC is shown. The polarization of the scattered beam was measured by a double scattering technique, and, for beam energies of 36, 40, and 45 MeV, was found to be 38.0 ± 3%, 35.5 ± 3%, and 28.8 ± 4% respectively. The use of α-p scattering as a source for polarized protons is also noted. (L.B.S.)

21494 NEUTRON DEPOLARIZATION IN THE ELASTIC SCATTERING FROM LANTHANUM AND IN THE INELASTIC SCATTERING FROM IRON. Schaller, L. A.; Walter, R. L.; Purser, F. O. (Duke Univ., Durham, N. C.). pp 314-15 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The polarization of neutrons scattered elastically from ^{139}La and inelastically from ^{56}Fe was measured using a spin-precision solenoid, a He-gas scintillator, and two plastic neutron detectors. The depolarization parameters were determined for both cases. (D.C.W.)

21495 POLARIZATION IN ELASTIC SCATTERING OF 25- AND 30-MeV PROTONS FROM COMPLEX NUCLEI. Craig, R. M.; Dore, J. C.; Lowe, J.; Watson, D. L. (Univ. of Birmingham, Eng.). pp 316-18 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Angular distributions of the polarization in the elastic scattering of 25- and 30-MeV protons by C, ^{58}Ni, ^{60}Ni, and ^{208}Pb were measured from 100 to 160°. The data were analyzed using the optical model. (D.C.W.)

21496 ELASTIC AND INELASTIC SCATTERING OF POLARIZED PROTONS FROM ^{60}Ni, ^{62}Ni, AND ^{12}C. Darriulat, P.; Fowler, J. M.; de Swiniarski, R.; Thirion, J. (CEN, Saclay, France). pp 342-4 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The polarization in scattering of polarized protons by ^{12}C, ^{60}N, and ^{62}Ni at 16.5 MeV and by ^{12}C at 19 MeV was measured as a function of scattering angle. The results were compared with optical-model predictions. (D.C.W.)

21497 SCATTERING OF POLARIZED PROTONS BY SELENIUM ISOTOPES. Hauser, I.; Hentschel, E. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). pp 345-6 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

An investigation of the effect of nuclear deformation on the polarization in scattering was begun. Separated isotopes of Se were bombarded with 11.5-MeV protons. Preliminary results on the polarization in scattering by ^{78}Se as a function of scattering angle are presented and are compared with optical-model predictions. (D.C.W.)

21498 ELASTIC SCATTERING OF 4.3- TO 5.1-MeV POLARIZED PROTONS BY NEON. Bem, P.; Habanec, J.; Karban, O.; Nemec, J. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). pp 352-3 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The angular distributions of the polarized protons scattered by Ne at 4.3 to 4.8 MeV were measured in an attempt to remove the ambiguity in the total momentum of the 6.25-MeV level of ^{21}Na. The experimental data could be fitted only by assuming $J^{\pi} = 3/2^+$ for the 6.25-MeV level. An assignment of $5/2^+$ was obtained for a level previously observed at a proton energy of 5.25 MeV. (D.C.W.)

21499 INVESTIGATION OF THE POLARIZATION AND THE DIFFERENTIAL CROSS SECTION IN SOME ^{58}Ni(d,p)^{59}Ni REACTIONS. Saladin, J. X.; Rollefson, A. A.; Brown, P. F. (Univ. of Pittsburgh). pp 507-9 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Differential cross sections and polarization angular distributions for ^{58}Ni(d,p)^{59}N; reactions to the ground state and the 0.47-, 0.887-, and 1.32-MeV states of ^{59}Ni were measured. The polarization was measured at forward angles, and the differential cross section was measured at angles between 15 and 140°. (D.C.W.)

21500 OPTICAL ORIENTATION OF ^{67}Zn. Spence, P. W.; McDermott, M. N. (Univ. of Washington, Seattle). Phys. Lett., 24A: 430-1(Apr. 10, 1967).

Nuclear orientation of ^{67}Zn produced by optically pumping with 3076 Å resonance radiation is reported. A comparison of the nuclear resonance frequency in free zinc atoms and of protons in the same magnetic field yields $\nu(^{67}\mathrm{Zn})/\nu(^{1}\mathrm{H}) = 0.062\ 524\ 1$. (auth)

21501 COULOMB DISPLACEMENT ENERGIES IN THE $1f_{\frac{7}{2}}$ SHELL. Sherr, R. (Princeton Univ., N. J.). Phys. Lett., 24B: 321-5(Apr. 3, 1967). (PUC-937-241).

The experimental data for Coulomb displacement energies in the mass region 33 to 65 are discussed. It is found for isobaric pairs of nuclei for which all nucleons in excess of 40 lie in the $1f_{\frac{7}{2}}$ shell that ΔE_c is with resonable accuracy given by the expression $\Delta E_c = 7220 + 300\ (Z_>' - 1' + 1) + (250/2T)[\frac{1}{2}(1 + (-1)^{Z_>'})]$ in keV, where $Z_>' = Z_> - 20$. There is essentially no A-dependence for these nuclei as either N or Z is changed. On the other hand, for isobaric pairs which involve several j-states or are in the $1d_{\frac{5}{2}}$ shell, ΔE_c for a set of isotopes varies approximately as $A^{-0.33}$. (auth)

21502 LIFETIME OF THE 3.46-MeV STATE OF ^{41}Sc BY PROXIMITY SCATTERING MEASUREMENTS. Lassen, L. (Univ., Heidelberg); Zahradnik, W.; Zeitnitz, B. Phys. Lett., 24B: 338-40(Apr. 3, 1967).

Neutron-proton scattering following the sequential decay ^{40}Ca(d,n)^{41}Sc*(p)^{40}Ca was measured to determine the lifetime of the intermediate state at 3.46-MeV excitation energy in ^{41}Sc. A value of 4×10^{-21} sec was obtained from the evaluation of the n-p rescattering intensity. (auth)

21503 COMPILATION AND MEASUREMENT OF DIFFERENTIAL CROSS SECTIONS FOR NEUTRON-INDUCED THRESHOLD REACTIONS. Liskien, H.; Paulsen, A. (EURATOM, Geel, Belg.). pp 352-7 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The Central Bureau for Nuclear Measurements of EURATOM has compiled and critically reviewed all the available differential cross-section data for twenty-four of the most important reactions. This compilation is kept up to date by supplement sheets. In order to improve the experimental situation, the Bureau has started its own measuring programme. Monoenergetic neutrons are produced by the reactions ^{3}H(p,n)^{3}He, ^{9}Be(α,n)^{12}C and ^{3}H(d,n)^{4}He, employing a 3 MeV electrostatic accelerator. The neutron flux is determined with a proton-recoil telescope counter, while the induced activities are measured by γ scintillation counters. With the aid of coincidence counting techniques it is also possible to measure cross sections for reactions leading to radioisotopes of relatively long half-life (^{22}Na, ^{54}Mn, ^{60}Co). A typical total uncertainty of the cross-section results is about ±6%. For the purpose of comparison and extrapolation of experimental data, theoretical cross-section calculations were carried out in the frame of the statistical model. The calculations with the complete statistical model agree with experimental data only to within a factor of 2. (auth)

21504 ACTIVATION CROSS SECTIONS FOR THE REACTIONS ^{54}Fe(n,p)^{54}Mn AND ^{58}Fe(n,γ)^{59}Fe IN NATURAL IRON. Carter, P. (Atomic Energy Research Establishment, Harwell, Eng.). pp. 331-40 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

Results are presented for two cross-section ratio measurements in the reactor PLUTO, ^{54}Fe(n,p)/^{58}Ni(n,p) for fast neutrons and ^{58}Fe(n,γ)/^{59}Co(n,γ) for thermal neutrons. Values obtained are 0.743 ± 0.018 and 0.0291 ± 0.0009. In addition, a survey of measurements of ^{54}Fe, ^{58}Nr and ^{32}S(n,p) and ^{27}Al(n,α) differential cross sections made in order to calculate the fission-neutron spectrum cross sections for these reactions. Results for a Cranberg fission spectrum are 77 ± 5, 108 ± 5, 63 ± 2.5, and 0.59 ± 0.04 mbn, respectively. From a comparison of the results reported and other published values, a value of 78 ± 2 mbn for the ^{54}Fe(n,p) fast-neutron activation cross section is recommended. This is based on an adopted cross section of 108 mbn for the reference ^{58}Ni reaction and a ^{54}Mn half-life of 314 days. An effective Westcott s value of 1.1 ± 0.2 is also reported for 0.014 in. diameter iron wire at an effective neutron temperature of 85°C. (auth)

21505 INVESTIGATION OF γ-RAY COINCIDENCES IN (n,γ) REACTIONS ON ^{50}Cr AND ^{53}Cr ISOTOPES. Bogdanov, A. P.; Tadeush, V. N.; Firsov, E. I. (Inst. of Physics, Minsk). Yadern. Fiz., 5: 504-9(Mar. 1967). (In Russian).

Cascade transitions accompanying the decay of the capture state in ^{51}Cr and ^{54}Cr isotopes from (n,γ) reactions with thermal neutrons were investigated using a scintillation coincidence spectrometer with NaI(Tl) crystals of diameter 70 mm and height 50 mm. The following cascade transitions (in MeV) were observed in the decay of the capture state in ^{51}Cr: 8.51−0.77; 7.37−1.90; 7.37−1.15−0.77; 6.37−1.37−1.55; 6.37−2.13−0.77; 6.12−3.15; 6.12−2.37−0.77; 5.48−3.02−0.77; and 5.20−3.29−0.77. The following cascade transitions (in MeV) were observed in the decay of the capture state of ^{54}Cr: 8.88−0.84; 7.11−1.77; 6.89−2.00; 6.64−2.23; 6.29−2.59, and 6.00−3.72. (auth)

21506 RESONANCE SCATTERING OF γ QUANTA BY ^{28}Si, ^{60}Ni, AND ^{66}Zn. Begzhanov, R. B.; Islamov, A. A. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz., 5: 483-9(Mar. 1967). (In Russian).

The resonance scattering of γ quanta emitted in the decays of ^{28}Al (half life, 2.31 min), ^{60m}Co (10.5 min), and ^{66}Cu (5.1 min) by the nuclei ^{28}Si, ^{60}Ni, and ^{66}Zn, respectively, was investigated. The lifetimes of the 2^+ levels were obtained using the self-absorption method. (auth)

21507 IRON ISOTOPE ^{61}Fe. Levkovskii, V. N.; Kazachevskii, I. V.; Sokolskii, V. V.; Vinitskaya, G. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 4: 1258-9 (Dec. 1966). (In Russian).

NiO targets containing natural nickel were irradiated with 14.8-MeV neutrons at a flux density of 10^3 n/cm^2 sec. The iron formed was separated; the specimens were measured by means of a scintillation β counter, a scintillation β spectrometer, and a single-crystal scintillation γ spectrometer. The radiochemically separated Fe fractions were found to include two activities with $T_{\frac{1}{2}}$ = 6 min and $T_{\frac{1}{2}}$ = 98 minutes. Analysis of the data indicated that the $T_{\frac{1}{2}}$ = 6-min activity belongs to ^{61}Fe, formed by the ^{64}Ni(n,α)^{61}Fe

reaction; the decay curve of the $^{61}Fe \rightarrow {}^{61}Co$ reaction indicated a $T_{1/2} = 6.0 \pm 0.1$ min. The β spectrum of ^{61}Fe contains 1.7-MeV lines; its γ spectrum exhibits 3 lines with nearly identical intensities and energies of 290 ± 10, 1070 ± 30, and 1220 ± 30 keV. It is concluded that earlier reports concerning the discovery of the new ^{64}Co and ^{63}Co isotopes and the corresponding cross sections of the $^{64}Ni(n,p)^{64}Co$ and $^{64}Ni(n,np)^{63}Co$ reactions are in error. (TTT)

21508 DOSE OF SECONDARY NEUTRONS PRODUCED BY 660-MeV PROTONS BEHIND FLAT SHIELDING OF NICKEL, COPPER, ALUMINUM, AND GRAPHITE. Kon'shin, V. A.; Matusevich, E. S.; Prokhorov, S. S. pp 239-44 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The flux and energy distribution of secondary neutrons escaping from plane layers of graphite, aluminum, nickel, and copper with a thickness of 26 g/cm^2 (approximately 10% of the ionization path of the primary protons) were measured for proton bombardment at 660 MeV. The experiments were done on the synchrocyclotron at the OIYal. The beam of protons incident on the target was monitored by the reaction $^{27}Al(p,3pn)^{24}Na$ with a cross section of (11 ± 0.5) mb at a proton energy of 660 MeV. The following indicators were used for measuring the number and energy distribution of the neutrons produced by reaction of the protons with target nuclei: $^{31}P(n,p)^{31}Si$; $^{27}Al(n,\alpha)^{24}Na$; and $^{24}Mg(n,p)^{24}Na$ with absolute registration of β-particles from decay of ^{31}Si and ^{24}Na. Tables are given showing neutron fluxes in various energy groups for interaction of 660-MeV protons with target nuclei behind a graphite target and in front of and behind copper, nickel, and aluminum targets, and for the doses produced by neutrons behind targets made from these four materials with an incident stream of protons. (ATD)

21509 ELASTIC SCATTERING OF 2.76-MeV NEUTRONS BY ^{40}Ca. Winterhalter, D. (Rudjer Boskovic Inst., Zagreb. Univ., Zagreb). Z. Phys., 200: 487-92(1967).

The elastic scattering of 2.76-MeV neutrons by calcium was studied using the nuclear emulsion technique. The angular distribution of the elastically scattered neutrons was compared with optical-model calculations. A satisfactory agreement with the theory was obtained. In addition, the total cross section for 2.76-MeV neutrons on calcium was measured by the transmission technique. (auth)

21510 SEPARATION OF NUCLEAR ISOMERS OF ^{133}Xe. Nefedov, V. D.; Kirin, I. S.; Tikhonov, V. I.; Zaitsev, V. M. Radiokhimiya, 8: 714-16(1966). (In Russian).

Results are given of preliminary experiments for separation of nuclear isomers ^{133}Xe based on the breakdown of the bond during isomer transitions in xenon compounds. The yield of ground-state ^{133}Xe was above 50%. The γ spectra of the xenon separated from XeF_4 crystals had an identical shape with the standard. (R.V.J.)

21511 (α,p) REACTIONS ON ^{26}Mg AND ^{27}Al IN THE 12 TO 16 MeV ENERGY RANGE. Semenescu, G.; Ivascu, M.; Dumitrescu, R.; Marincu, E.; Titirici, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 11: 621-31(1966).

The $^{26}Mg(\alpha,p)^{29}Al$ and $^{27}Al(\alpha,p)^{30}Si$ reactions were studied using alpha particles with energies between 12 and 16 MeV. The angular distributions and excitation functions for several proton groups corresponding to the ground state and the first excited states in residual nuclei were measured. The angular distributions and the excitation functions show that the direct interaction has an important contribution to the cross-section and that the mechanism of formation of the compound nucleus is present particularly at lower energies. The experimental data of the angular distributions obtained at E = 14.8 MeV were compared with Butler's stripping and with the diffraction model for $^{26}Mg(\alpha,p_0)^{29}Al$, $^{27}Al(\alpha,p_0)^{30}Si$, and $^{27}Al(\alpha,p_1)^{30}Si$ reactions. The $^{27}Al(\alpha,p_1)^{30}Si$ reaction was compared also with the results obtained by means of McCarthy's and Pursey's method. (auth)

21512 ^3He INDUCED REACTIONS ON ^{32}S AT 12 MeV BOMBARDING ENERGY. Graue, Arnfinn (Univ. of Bergen). Phys. Norv., 2: No. 1, 7-23(1966).

The $^{32}S(^3He,^3He)^{32}S$, $^{32}S(^3He,d)^{33}Cl$, and $^{32}S(^3He,\alpha)^{31}S$ reactions were studied at a bombarding energy of 12 MeV using doubly ionized $^3He^{++}$ accelerated in the MIT-ONR Van de Graaff-generator. A broad-range multiple-gap spectrograph was used in the detection of the reaction products. Absolute Q-values of the ground-state transitions for the $^{32}S(^3He,d)^{33}Cl$ and the $^{32}S(^3He,\alpha)^{31}S$ reactions were measured. Excitation energies of levels in ^{33}Cl and ^{31}S were determined with accuracies of 4 and 10 keV, respectively. Energy levels in ^{33}Cl were found at 0.810, 2.675, and 2.835 MeV. In ^{31}S levels are observed at 1.243, 2.221, and 3.274 MeV. Absolute cross sections were measured for the (^3He,d) and ($^3He,\alpha$) reactions. Angular distributions of the reaction products were analyzed by means of distorted-wave Born approximation calculations using optical-model parameters derived from elastic scattering of 12-MeV ^3He particles on ^{32}S. The data for the elastic scattering are given together with the optical-model fits. The values of l, the orbital angular momentum of the transferred nucleon in the stripping and pick-up reactions, were determined. Strength functions or spectroscopic factors are extracted from the comparison of the measured and calculated differential cross sections. The spectroscopic information obtained is compared with predictions from the shell-model calculations of Glaudemans et al. in which an inert ^{28}Si core and two-particle interaction of nucleons in the outer $2s_{1/2}$ and $1d_{5/2}$ configurations are assumed. (auth)

21513 NUCLEAR ORIENTATION OF ^{57}Co IN CERIUM ZINC NITRATE. Strohm, Walter Williams Jr. Lawrence, Kan., Univ. of Kansas, 1966. 113p.

Thesis.

The radiation patterns and linear polarization of gamma rays from the decay of ^{57}Co nuclei alligned by Bleaney's method of cerium zinc nitrate at $1/T^* = 157°K^{-1}$ were studied for evidence of intermediate state reorientation in the 137-keV state of ^{57}Fe. Influence of spin-spin interactions is assumed to be negligible at this temperature from the results of alignment of ^{60}Co by the same method. Experimental results, expressed in terms of the mixing ratio $\delta = \pm(E2/M1)^{1/2}$ and the attenuation coefficient Q_k in the angular distributions $W(\theta) = \Sigma_k Q_k A_k P_k (\cos\theta)$ are: $\delta = +0.158 \pm 0.005$, $Q_2 = 1.03 \pm 0.19$ for the 123 keV gamma ray; and $Q_2 = 0.90 + 0.19$ for the pure E2, 137 keV gamma ray. This compares with a value of $\delta = 0.19$ and $Q_2 = 0.11$ obtained earlier at Oxford University from measurements on ^{57}Co aligned in the copper tutton salt at $1/T^* = 80°K^{-1}$. The results obtained are inconsistent with an attenuation in excess of 16% in the coefficient of P_2 in the gamma ray angular distribution and are consistent with no observable effect, within the limits of experimental error, of intermediate state reorientation. (Dissertation Abstr.)

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Refer also to abstracts 21426, 21441, 21453, 21463, 21479, 21482, 21483, 21494, 21495, and 21789.

21514 (AE-268) ON THE PROPERTIES OF THE $s_{1/2} - d_{5/2}$ TRANSITION IN ^{199}Au. Baecklin, A.; Malmskog, S. G. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Feb 1967. 25p. Dep. mn.

The half life of the first excited level in ^{199}Au was measured by the delayed coincidence technique to be 1.1 ± 0.1 nsec. From a measurement of the intensity ratios of the L-sub shell conversion lines, the E2/M1 ratio of the deexciting transition was found to be 4.9×10^{-2}. The energy of the transition was measured to 77.21 ± 0.03 keV. The absolute values of the reduced M1 and E2 transition probabilities were calculated and were included in a systematic survey of $s_{1/2} - d_{5/2}$ transition in odd-Z isotopes in the Au region. This result was compared with the predictions of the nuclear models of Sorensen and de Shalit. (auth)

21515 (AEEW-M-714) ^{241}Pu CROSS-SECTIONS BELOW 1 keV. Doherty, G. (Atomic Energy Establishment, Winfrith (England)). Dec. 1966. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn, HMSO 3s. 0d.

Early in 1965 a new data file for neutron reactions with ^{241}Pu covering the energy range 10^{-4} eV to 15 MeV was prepared for the UKAEA Nuclear Data Library. The data above 1 keV are described by Douglas (AWRE 0-101/64) and the data below 1 keV are set out in the present report. During the past year a number of additional measurements have been reported for ^{241}Pu, and a brief summary of these measurements and their implications for the data on the file are given. (auth)

21516 (BMwF-FBK-67-10) DIFFERENTIELLE MESSUNG DER INNEREN BREMSSTRAHLUNG VON ^{90}Y. (Differential Measurement of the Internal Bremsstrahlung of ^{90}Y). Trebst, H.-J. (Erlangen Univ. (West Germany). Physikalisches Institut). Feb. 1967. 20p. (In German). Dep. mn.

The internal bremsstrahlung (IB) of ^{90}Y was measured as a function $S(k,E,\vartheta)$ of the IB energy, k, the electron energy, E, and the angle ϑ. The measurement was made at three different angles and for the electron between 0.58 and 2 MeV and IB energies between 0.1 and 1.8 MeV. The resulting IB transition probabilities are in agreement with the theory of Knipp and Uhlenbeck, Bloch and Lewis and Ford, respectively. (auth)

21517 (INSJ-103) NUMERICAL DIFFERENTIAL CROSS SECTIONS OF ELASTIC AND INELASTIC SCATTERING OF 14 MeV PROTONS FROM ^{111}Cd, ^{112}Cd AND ^{113}Cd NUCLEI. Koike, Masahiro (Institute for Nuclear Study, Tokyo Univ. (Japan)). Feb. 6, 1967. 37p. Dep. mn.

Numerical values of the differential cross sections for elastic and inelastic scattering of 14.2 to 14.7-MeV protons from ^{111}Cd, ^{112}Cd, and ^{113}Cd are presented. The proton beam extracted from the INS 160 cm cyclotron was analyzed by a magnet system. The energy spread of the analyzed proton beam was estimated to be 20 keV. Momentum analysis of the scattered protons was made with a broad-range magnetic spectrometer. For the detection of the analyzed particles, a 250-channel solid-state detector array was arranged along the focal plane of the magnetic spectrometer. The active area of each unit of the solid-state detector was 2 mm in width and 8 mm in height. Dead spaces of 2 mm between the detectors were covered by a 2-mm shift of the detector array along the focal plane. The signals from the detectors were stored into a TMC CN 1024-channel core memory (operated in a 4 × 256 mode). The data were printed out through punched paper tapes. The effective solid angle of the spectrometer was estimated to be $2.0 \pm 0.3 \times 10^{-4}$ steradian. The energy resolution of the spectrometer system, on an average, was 0.2%. The thickness of the ^{111}Cd, ^{112}Cd, and ^{113}Cd targets was 1.08, 1.11, and 0.710 mg/cm^2, respectively. The target foils were prepared by electrodeposition from a cadmium-sodium cyanide solution. Typical spectra of protons scattered from ^{111}Cd, ^{112}Cd, and ^{113}Cd are shown. The excitation energies (in MeV) indicated are the average of the values obtained at several scattering angles. Angular distributions of the scattered protons were measured at every 10° between 20 and 140°. (auth)

21518 (JINR-E6-3142) DELAYED PROTON EMITTER ^{111}Te. Bogdanov, D. D.; Darotsi, Sh.; Karnaukhov, V. A.; Petrov, L. A.; Ter-Akop'yan, G. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 20p. Dep. mn.

A 19.5 sec delayed proton emitter produced by the reaction ^{102}Pd + ^{12}C was studied. It was identified as ^{111}Te by means of the excitation function. The proton spectrum measured by a surface-barrier detector with a resolution of 25 to 30 keV has a complicated structure due to a high level density of the daughter nuclide. The analysis of the averaged shape of the proton spectrum was performed. The shape is determined by the population of the excited states in beta-transition, by level density, and proton width. The calculated shape is in best agreement with the experimental one on the assumption that the averaged squared matrix element of beta-transition reduces exponentially with increasing excitation energy of the daughter nucleus. (auth)

21519 (JINR-P4-3171) VLIYANIE SPIN-KVADRUPOL'NYKH VZAIMODEISTVII NA SKOROST RAZRESHENNYKH BETA-PEREKHODOV. (The Spin-Quadrupole Force Effect on the Allowed β-Decay Rate). Kuliev, A. A.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 18p. (In Russian). Dep.mn.

The allowed β-decay rates to 0^+ and 2^+ collective states in deformed nuclei were calculated. It is shown that an appreciable retardation of the β decay to the lowest 0^+ states in ^{164}Er and ^{178}Hf nuclei is due to the spin-quadrupole force. The calculated energy, B(E2) and log ft values are in good agreement with experimental data. (auth)

21520 (JINR-P6-3127) ISSLEDOVANIE IZLUCHENIYA ^{151}Gd. (The Decay of ^{151}Gd). Gromov, K. Ya.; Kuznetsov, V. V.; Nenov, P.; Nil'sen, O. B.; Skilbrait, O.; Fominykh, V. I.; Khristov, D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 15p. (In Russian). Dep. mn.

The conversion-electron and γ spectra of ^{151}Gd were studied. The conversion-electron spectrum was investigated by using a toroidal six-gap β spectrometer (Apelsin type). The γ spectrum was studied by using a Ge(Li) semiconductor detector. The transition multipolarity and the electron-capture population of ^{151}Eu levels are determined. The scheme of ^{151}Eu levels is discussed. (auth)

21521 (N-67-12923) ANGULAR CORRELATION OF CASCADE GAMMA RAYS IN ^{94}Nb. Kuebbing, R. A.; Casper, K. J. (Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). 1966. 13p. (NASA-CR-80193). CFSTI $3.00 cy, $0.65 mn.

The directional correlation and polarization correlation of the 703 to 871 keV gamma cascade following the decay of ^{94}Nb were measured. On the basis of these measurements, the spin and parity of the 1574-keV level in ^{94}Mo was determined to be 4. (auth)

21522 (UCRL-50183) ESTIMATES OF ALPHA-DECAY LIFETIMES FOR SUPERHEAVY NUCLEI. Truran, J. W. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 27, 1967. Contract W-7405-eng-48. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An alpha-decay systematics is developed, based on a study of the variations in the reduced widths. The barrier penetration factors are determined accurately from the solutions to the Coulomb wave equation. Regularities in the behavior of the reduced widths for l = 0 transitions for nuclei $90 \leq Z \leq 100$ permit extrapolations into the neutron-rich regions. (auth)

21523 (BNL-tr-126) NEUTRON SPECTROSCOPIC INVESTIGATION OF SEPARATED CADMIUM ISOTOPES. Shepkin, Yu. G.; Adamchuk, Yu. V.; Danelyan, L. S.; Muradyan, G. V. Translated for Brookhaven National Lab., Upton, N. Y., from Paper Presented at IAEA Conference on Nuclear Data, Paris, France, October 17-21, 1966. 12p. (CONF-661014-49). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Total neutron cross sections were measured on ^{111}Cd and ^{113}Cd using a time-of-flight spectrometer and a pulsed neutron source. Radiative capture cross sections were measured for ^{110}Cd, ^{111}Cd, ^{112}Cd, ^{113}Cd, ^{114}Cd, and ^{116}Cd using enriched samples of varying thickness. Neutron widths, radiative widths, and spin were determined for levels in these isotopes. The values obtained for the level parameters were used for calculating the most probable values of the force functions S* and the most probable values of the mean level spacing D*. In determining the mean level spacing D, reduced to one excitation energy of 6.5 MeV, a statistical formula for the level density was used. The values of S*, D*, and D are tabulated. (S.F.L.)

21524 THERMAL-NEUTRON CAPTURE CROSS SECTION OF ^{147}Sm. Forman, L.; White, F. A. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng., 28: 139-43(Apr. 1967).

The thermal-neutron capture cross section of ^{147}Sm was measured by the mass spectrometric determination of the number of ^{148}Sm atoms formed by neutron capture. Samples of high isotopic purity were irradiated in a well-thermalized neutron spectrum for which the time-integrated neutron flux and effective neutron temperature were monitored by the burnup in ^{149}Sm and ^{157}Gd. A thermal-neutron capture cross section value of 75 ± 11 b was obtained from a post-irradiation ^{148}Sm/^{147}Sm ratio of 0.00025 ± 8%, at an effective neutron temperature of 127 ± 13°C. (auth)

21525 TOTAL NEUTRON CROSS SECTION OF ^{233}Pa. Simpson, F. B.; Codding, J. W. Jr. (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Sci. Eng., 28: 133-8(Apr. 1967).

Transmission measurements on ^{233}Pa were taken with the Materials Testing Reactor (MTR) fast chopper. The total cross section was calculated in the energy range from 0.01 to 10,000 eV. These measurements were made on 700 mg of chemically separated ^{233}Pa in an oxide form. The protactinium was produced by irradiating 280 g of ^{232}Th in the Engineering Test Reactor. The sample represented approximately 15,000 Ci of activity. The data were taken with a resolution of 0.08 to 2.0 μsec/m. The Breit-Wigner resonance parameters were obtained for the resonances below 18 eV. The average parameters give a value of 0.75×10^{-4} for the s-wave neutron strength function $\overline{\Gamma_n^0}/D$. Weighting the level spacings inversely as 2J + 1 gives the average observed level spacings per spin state of 1.10 and 1.84 eV. A second-order polynomial least-squares fit to the $\sigma_T\sqrt{E}$ data between 0.01 and 0.10 eV gives a 2200 m/sec total neutron cross section of 55 ± 3 b, superseding a value of 57 b given previously. The resonance-absorption integral for neutrons with energies above 0.4 eV was calculated to be 901 ± 45 b. (auth)

21526 INELASTIC SCATTERING MEASUREMENTS IN A FAST REACTOR BY THE SPHERICAL SHELL METHOD. Davey, William G.; Amundson, Paul I. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 28: 111-23(Apr. 1967).

The spherical shell method for investigating inelastic scattering cross sections was used in a fast-reactor core environment. The changes in ^{238}U/^{235}U, ^{236}U/^{235}U, and ^{234}U/^{235}U fission ratios caused by placing shells of graphite, sodium, aluminum, ion, stainless steel, lead, and depleted uranium around the fission chambers were measured. The studies show that reasonably accurate measurements can be made in a fast-reactor core. When comparisons can be made, our results are in excellent agreement with the fission spectrum results of Bethe, Beyster, and Carter. Comparisons of the experimental data with values calculated using two multigroup cross-section sets show clearly where these data sets are accurate and where they are in error. (auth)

21527 MEASUREMENT OF FISSIONS PRODUCED IN BULK ^{239}Pu BY 2-eV TO 10-keV NEUTRONS. Czirr, J. B.; Bramblett, R. L. (Univ. of California, Livermore). Nucl. Sci. Eng., 28: 62-71(Apr. 1967). (UCRL-14153(Rev.1)).

This experiment was conducted to obtain data to be used in calculating the number of fissions produced by neutrons in bulk ^{239}Pu as a function of neutron energy. The data provide a consistent set of group-averaged cross sections and self-shielding factors. Although self-shielding factors have been calculated from cross-section data, no previous experiments to measure the energy dependence of ^{239}Pu self-shielding exist. A consistent set of cross

sections is possible because of the wide neutron energy range over which this experiment was done. No attempt was made to determine resonance parameters, since in this experiment poor energy resolution was used to improve statistics. Resonance parameters are, in fact, unnecessary to determine group-averaged cross sections and room-temperature self-shielding factors. Good-geometry self-shielding factors were measured by a Pu fission counter shielded by various thicknesses of Pu. Average fission cross sections, total cross sections, and self-shielding factors were determined in 11 energy groups whose end points are in the ratio of 2.15-to-1. The energy range was 2.15 eV to 10 keV. The LRL Linac neutron time-of-flight facility was used, with a neutron resolution of 0.18 μsec/m. The detector consisted of a spark chamber that was sensitive to fission fragments, facing a 0.4 mg/cm^2 ^{239}Pu foil. Seven Pu absorber foils ranging from 0.06 to 3 g/cm^2 were used in the self-shielding measurements. This range of absorber thickness yields an adequate description of the resonance-produced surface-absorption effect throughout the above energy region. (auth)

21528 DECAY OF ^{95}Ru. Heuer, Dieter (Univ., Goettingen, Ger.). Z. Phys., 201: 142-52(1967). (In German).

The γ-spectrum of ^{95}Tc associated with the E.C. and β^+ decay of ^{95}Ru was measured with a Ge(Li) counter and a NaI crystal. 12 new γ-ray transitions were found in these spectrums. To propose a new level-scheme γ–γ-coincidences were taken with 2 NaI-crystals in a two-dimensional device. Besides this the total conversion coefficient of the 336 keV transition was measured by detecting the electrons in a Si(Li) counter and the γ-rays in a NaI crystal. (auth)

21529 THE (n,α)-REACTION WITH 15-MeV NEUTRONS OF THE NUCLEI ^{138}Ba, ^{140}Ce, AND ^{142}Nd. Staudt, Guenter (Univ., Tuebingen, Ger.). Z. Phys., 201: 105-16(1967). (In German).

Studies of the (n,α)-reactions on ^{138}Ba, ^{140}Ce, and ^{142}Nd for a neutron energy of 15 MeV are presented. The energy and angular distribution of the emitted α-particles was measured with a Si-semiconductor detector. The shape of the energy spectra and the angular distributions predominantly show a direct reaction mechanism in the studied energy region E_α > 16 MeV. The measured total cross sections are 10 ± 3 mb for Nd, 7 ± 2 mb for Ce and 3 to 5 mb for the Ba reaction. The angular distributions and the values of the total cross sections are discussed. (auth)

21530 COMMENT ON THE CALCULATION OF THE SCATTERING CROSS SECTION FOR MULTIPLE RESONANCES. Otter, John M. (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 28: 149-50(Apr. 1967).

An expression for scattering cross sections that takes into account interference between potential and resonance scattering is presented together with the results of calculations for ^{242}Pu in which the 2.6- and 53.6-eV resonances were considered. (D.C.W.)

21531 DEUTERON ABSORPTION COEFFICIENTS AND REACTION CROSS SECTIONS CALCULATED WITH OPTICAL MODEL POTENTIALS. Melkanoff, M. A. (CEN, Saclay, France); Sawada, T.; Cindro, N. Nucl. Data, Sect. A, 2: 263-79 (Sept. 1966).

Tables of deuteron absorption coefficients and reaction cross sections are presented for C, Mg, Ni, Rh, Nd, and Au at deuteron energies of 4 to 28 MeV. These were obtained from optical model calculations using parameters previously published by the authors [Phys. Letters 2: 98(1962)]. (auth)

21532 NUCLEAR ORIENTATION OF ^{95}Nb NUCLEI IN IRON AND COBALT. Cameron, J. A.; Campbell, I. A.; Compton, J. P.; Lines, R. A. G.; Wilson, G. V. H. (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 90: 1089-94(Apr. 1967).

Measurements were made of the anisotropy and plane polarization of the 768-keV γ radiation from ^{95}Nb nuclei oriented in iron at temperatures from 0.013 to 0.05°K. A value δ = 0.05 ± 0.01 was obtained from the E2/M1 γ radiation, mixing ratio. The magnetic moment of ^{95}Nb was found to be 6.3 ± 0.6 nm. From low-temperature measurements of the anisotropy and circular polarization of the γ radiation from ^{95}Nb nuclei in cobalt, the hyperfine field on niobium nuclei in a dilute alloy of niobium in cobalt was found to be H_e = −189 ± 8 kOe. (auth)

21533 RADIOACTIVE DECAY OF ^{186}Re. Murty, V. Radhakrishna (Panjab Univ., Chandigarh, India); Jnanananda, Swami. Curr. Sci. (India), 36: 195-7(Apr. 20, 1967).

Gamma spectra from the decay of ^{186}Re were measured. Relative intensities and branching ratios were determined. (D.C.W.)

21534 ISOMERISM IN ^{133}Ce. Gerschel, Claudie; Albouy, Georgette (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. B, 264: 183-6(Jan. 9, 1967). (In French).

With the aid of a Ge detector, the existence of an isomeric state of ^{133}Ce was shown. Its half life was measured to be 97 ± 4 min. (tr-auth)

21535 STUDY OF THE HIGH ENERGY γ RADIATION OF ^{132}I USING A PAIR SPECTROMETER. Ythier, Christian; Ardisson, Gerard; Lefort, Marc. (Faculte des Sciences, Nice). Compt. Rend., Ser. B, 264: 84-6(Jan. 4, 1967). (In French).

The gamma radiation of chemically separated ^{132}I was studied using a pair spectrometer with a Ge n-i-p diode as the central detector. In the energy range above 1.29 MeV, ten previously unreported γ rays were observed. The energies and relative intensities of the high-energy gamma rays are presented. (tr-auth)

21536 THE MEASUREMENT OF ^{239}Pu CAPTURE TO FISSION RATIOS IN FAST REACTOR LATTICES. Fox, W. N.; Richmond, R.; Skillings, D. J.; Wheeler, R. C. (Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 6: 63-79(Jan. 1967).

The breeding gain of plutonium fuelled fast reactors is strongly influenced by the capture-to-fission ratio α_9 of ^{239}Pu. In the softer spectra associated with a large dilute fast reactor, the uncertainty in α_9 is of the order of ±25%. To reduce this uncertainty, two new techniques are being developed for use in zero-energy fast reactor lattices. In the first method, measurements are made in a lattice which is arranged to have an infinite multiplication constant k_∞ near to unity, so that k_∞ can be determined by a null reactivity technique without introducing significant systematic errors. All the important neutron fission and capture rates, except for the capture rate in ^{239}Pu, are then measured in this modified lattice; and α_9 is inferred from the known neutron balance. The second method, which is at an earlier stage of development than the first, involves the direct observation of capture and fission γ rays from a ^{239}Pu sample placed in a neutron beam taken from the zero-energy fast reactor core. A coincidence technique is used to distinguish between capture and fission γ rays, and the apparatus is calibrated by repeating the measurement in a thermal neutron beam for which α_9 is known. Some preliminary results obtained by the first technique indicate that current nuclear data sets underestimate α_9 significantly in dilute fast reactor lattices. (auth)

21537 THE AKHIESER–POMERANCHUK–BLAIR MODEL ANALYSIS OF THE ELASTIC SCATTERING OF 24.7-MeV ALPHA-PARTICLES FROM HEAVY NUCLEI. Khan, A. H. (Atomic Energy Centre, Dacca, Pakistan); Rahman, M.; Sen Gupta, H. M. Nuovo Cimento (10), 48B: 13-18(Mar. 11, 1967). (AECD-TP-13).

The measured angular distributions of 24.7-MeV alpha particles elastically scattered from the nuclei Ag, In, Sn, Hf, W, Au, Bi, and U were analyzed in terms of the improved Akhieser–Pomeranchuk–Blair model. In these analyses, the parameters l_A and Δl_A, respectively, the cut-off angular momentum and the range of partial waves over which the transition from complete absorption to no absorption takes place, were found to be adequate; and good agreement with experimental results could be obtained. (auth)

21538 A NEW 15-MIN ISOMER IN ^{142}Pr. Kern, J.; Mauron, G.; Michaud, B. (Univ. of Fribourg, Switzerland). Phys. Lett., Part B, 24: 400-1(Apr. 17, 1967).

A previously unreported isomer of ^{142}Pr with a half life of 14.6 ± 0.5 min was discovered. The activation cross section of this isomer by thermal neutron capture is 3.7 ± 0.5 b. (auth)

21539 HALF LIFE DETERMINATION OF SOME SHORT-LIVED ISOTOPES OF Rb, Sr, Cs, Ba, La, AND IDENTIFICATION OF $^{93\ 94\ 95\ 96}$Rb AS DELAYED NEUTRON PRECURSORS BY ON-LINE MASS-SPECTROMETRY. Amarel, I.; Bernas, R.; Foucher, R.; Jastrzebski, J.; Johnson, A.; Teillac, J.; Gauvin, H. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett., Part B, 24: 402-4(Apr. 17, 1967).

A mass spectrometer on-line with the Orsay 150-MeV proton synchrocyclotron was used to determine the β half life of ^{90}Rb, ^{91}Rb, ^{92}Rb, ^{93}Rb, ^{94}Rb, ^{95}Rb, ^{96}Rb, ^{94}Sr, ^{95}Sr, ^{96}Sr, ^{143}Cs, ^{144}Cs, ^{144}Ba, and ^{144}La. Identification of ^{93}Rb, ^{94}Rb, ^{95}Rb, and ^{96}Rb as delayed neutron precursors and preliminary indication of ^{142}Cs and ^{143}Cs as being neutron precursors were established. The existence of an isomeric state in ^{90}Rb appears likely in view of the measured half lives and γ spectrum of this isotope. (auth)

21540 E2/M1 MIXING RATIOS OF TRANSITIONS IN ^{170}Tm. Baecklin, A. (Univ. of Uppsala. Swedish Research Councils' Lab., Studsvik, Sweden). Phys. Lett., Part B, 24: 389-92(Apr. 17, 1967).

Internal-conversion lines from transitions within and between K = 1$^-$ and K = 0$^-$ bands in ^{170}Tm were measured with the reaction ^{169}Tm(n,γ)^{170}Tm. Values of B(M1) and B(E2) were deduced. Some deviations were found from the predictions of the simple rotational model. (auth)

21541 MOESSBAUER EFFECT IN ^{166}Er AND g FACTORS FOR THE LOWEST 2^+ STATES OF SOME ISOTOPES OF Dy, Er, AND Yb. Muenck, E.; Quitmann, D.; Huefner, S. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., Part B, 24: 392-4 (Apr. 17, 1967).

Using the Mössbauer technique, the gyromagnetic ratio $g^{164} = 0.350 \pm 0.012$ was determined for ^{166}Er using $ErCl_3 \cdot 6H_2O$ as absorber. A value of $g^{164}/g^{166} = 1.103 \pm 0.015$ was obtained. Earlier results for ^{164}Dy, ^{168}Er, ^{172}Yb, and ^{174}Yb are summarized. (auth)

21542 CHANGE OF THE NUCLEAR RADIUS IN THE K = ½ ROTATIONAL BAND OF ^{169}Tm. Schaller, H.; Kaindl, G.; Wagner, F.; Kienle, P. (Technische Hochschule Munich). Phys. Lett., Part B, 24: 397-8 (Apr. 17, 1967).

The isomer shift of the 8.42-keV recoilless γ rays of ^{169}Tm was measured. The mean-square charge radius of the 8.42-keV rotational state is $0.36 \pm 0.12 \times 10^{-3}$ fm^2, which is smaller than that of the ground state. (auth)

21543 A REMARK CONCERNING THE MAGNETIC PROPERTIES OF THE ODD-ODD NUCLEUS ^{170}Tm. Ryde, H. (Univ. of Stockholm. Research Inst. for Physics, Stockholm); Boehm, F.; Symons, G. D.; Szymanski, Z. Phys. Lett., Part B, 24: 387-8 (Apr. 17, 1967).

The gyromagnetic ratios of the ground-state rotational band in ^{170}Tm are found from experimental data to be $g_K = 0.17$ and $g_R = 0.33$. (auth)

21544 ISOBARIC ANALOG SYSTEMATICS AND SPECTROSCOPY IN THE LEAD ISOTOPES. Lenz, G. H.; Temmer, G. M. (Rutgers State Univ., New Brunswick, N. J.). Phys. Lett., Part B, 24: 368-72(Apr. 17, 1967).

Certain systematic features of isobaric analog resonances observed in elastic and inelastic proton scattering from the lead isotopes are pointed out, such as the properties of the 2_{g_9} particle states and others related to them. Coulomb displacement energies for the Pb–Bi pairs are presented. (auth)

21545 THE 0^+ STATES OF EVEN TIN ISOTOPES AND THE FOUR-QUASI-PARTICLE TAMM–DANCOFF APPROXIMATION. Ottaviani, P. L. (CNEN, Bologna); Savoia, M.; Sawicki, J. Phys. Lett., Part B, 24: 353-6(Apr. 17, 1967).

The even-parity states of even tin isotopes are studied in the framework of the quasiparticle second Tamm-Dancoff approximation. In contrast to the 2^+ and 4^+ states, even the lowest-lying 0^+ states are found to have high weights of four-quasiparticle components. While the shift of the ground-state energy due to the four-quasiparticle correlations is generally small, the corresponding eigenvector is modified quite appreciably. (auth)

21546 PHOTONUCLEAR REACTIONS ABOVE THE MESONIC THRESHOLD. III. GAMMA-NEUTRON REACTIONS IN IODINE AT ENERGIES BETWEEN 300 AND 1000 MeV. di Napoli, V. (CNEN, Rome. Univ., Rome); Dobici, F.; Salvetti, F.; de Carvalho, H. G. Nuovo Cimento (10), 48B: 1-12(Mar. 11, 1967).

The absolute cross sections in the energy range from 300 to 1000 MeV for (γ,n), $(\gamma,2n)$, and $(\gamma,3n)$ reactions on ^{127}I are reported. The σ_K for these reactions are proportional, respectively, to 125, 29, and 1. This seems to be due to a frequent process in which the high-energy photon gives only a low-energy excitation to the nucleus. (auth)

21547 SOME EXPERIMENTS WITH POLARIZED THERMAL NEUTRONS. Abrahams, K.; Ratynski, W.; Stecher-Rasmussen, F.; Warming, E. (Risoe Research Establishment, Roskilde, Denmark). pp 377-9 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A system for the polarization of thermal neutrons by reflection from magnetized Co mirrors is briefly described, and the use of polarized thermal neutrons in spin and parity studies is briefly discussed. Some experimental results are summarized. (D.C.W.)

21548 POLARIZATION IN THE SMALL-ANGLE SCATTERING OF 0.83-MeV NEUTRONS BY U. Lane, R. O.; Elwyn, A. J.; Monahan, J. E.; Langsdorf, A. Jr.; Mooring, F. P. (Argonne National Lab., Ill.). pp 468-9 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Differential cross sections and polarizations for the scattering of 0.83-MeV neutrons by U at angles of 1.65, 2.35, 4.6, and 10° were measured. The results were compared with theoretical predictions. (D.C.W.)

21549 EXPERIMENTAL EVIDENCE OF AN INTERMEDIATE STRUCTURE IN THE ENERGY DEPENDENCE OF THE POLARIZATION OF FAST NEUTRONS. Aspelund, O.; Higbie, J. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 470-3 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Finite-geometry left-right ratios were observed in the scattering of fast neutrons by Bi and Pb at several angles between 30 and 129° in the laboratory system. Evidence of an intermediate structure in the energy dependence of the polarization was obtained. (D.C.W.)

21550 DECAY OF THE 52-SEC ISOMER OF ^{196}Ir. Monnand, Edouard; Pinston, Jean-Alain; Henck, Roland (Centre d'Etudes Nucleaires, Grenoble, France. Centre de Recherches Nucleaires, Strasbourg). Compt. Rend., Ser. B, 264: 330-3(Jan. 23, 1967). (In French).

The decay of ^{196}Ir, produced by the reaction ^{196}Pt(n,p)^{196}Ir, was studied by β and γ spectrometry; γ rays at 333, 356, 448, and 781 keV were detected. The maximum energy of the β spectra is 3.250 MeV. The half life of this isomer is 52 ± 2 sec. The decay scheme of ^{196}Ir → ^{196}Pt was given for the low-lying excited levels of ^{196}Pt. (tr-auth)

21551 MICROSCOPIC BOSON DESCRIPTION OF VIBRATIONAL STATES IN ^{114}Cd. Soerensen, B. (NORDITA, Copenhagen). Phys. Lett., 24B: 328-30(Apr. 3, 1967).

Boson expansion techniques are applied to a pairing plus quadrupole force. Anharmonic parts of the Hamiltonian and of the E2 operator are included in the branch of collective quadrupole excitations. Up to third-order anharmonicities were included in the calculation, but at least the B(E2) values and static quadrupole moments are presumably not much influenced by higher-order terms. In fact, the numerical results are in reasonable agreement with experiments, including the large static moment of the first excited 2^+ state. (auth)

21552 NEW CALIFORNIUM ISOTOPE, ^{242}Cf. Sikkeland, T.; Ghiorso, A. (Univ. of California, Berkeley). Phys. Lett., 24B: 331-2(Apr. 3, 1967).

A previously unreported isotope of californium was produced in the bombardments of ^{233}U, ^{234}U, ^{235}U, and ^{236}U with ^{12}C ions. It decays with a half life of 3.4 ± 0.2 min by the emission of α particles with an energy of 7.39 ± 0.02 MeV. From an analysis of the excitation functions, it is concluded that the isotope has a mass number of 242. (auth)

21553 DECAY PROPERTIES OF THE NEW ISOTOPE ^{243}Cf AND OF ^{244}Cf. Sikkeland, T.; Ghiorso, A.; Maly, J.; Nurmia, J. (Univ. of California, Berkeley). Phys. Lett., 24B: 333-4(Apr. 3, 1967).

A previously unreported isotope of californium ^{243}Cf was produced in the bombardments of ^{235}U, ^{236}U, and ^{238}U with ^{12}C ions. At the same time new values for the half life and α-particle energy observed in the decay of ^{244}Cf were obtained. (auth)

21554 NUCLEAR PROPERTIES OF ^{242}Cf, ^{243}Cf, ^{244}Cf, AND ^{245}Cf. Fields, P. R.; Barnes, R. F.; Sjoblom, R. K.; Milsted, J. (Argonne National Lab., Ill.). Phys. Lett., 24B: 340-1(Apr. 3, 1967).

Irradiations of ^{242}Cm and ^{244}Cm by ^{3}He ions produced two new isotopes of californium. ^{242}Cf emits a 7.35 ± 0.01 MeV α-particle group and has a half life of 3.2 ± 0.5 min. ^{243}Cf emits 7.06 ± 0.01 and 7.17 ± 0.01 MeV α-particle groups and decays with a half life of 12.5 ± 1.0 min. New values for the α-particle energies and half lives were obtained for ^{244}Cf and ^{245}Cf. (auth)

21555 SYSTEMATICS OF FISSION PRODUCT X-RAY INTENSITIES. John, W.; Massey, R.; Saunders, B. G. (Univ. of California, Livermore). Phys. Lett., 24B: 336-8(Apr. 3, 1967). (UCRL-70298).

The K x rays of fission products from thermal neutron capture in ^{235}U were studied with a high-resolution, bent-crystal spectrometer. Systematic variations of the x-ray intensities with atomic number are found. (auth)

21556 ^{97}Zr IN THE SPONTANEOUS FISSION OF ^{238}U. Rao, M. N. (Univ. of Cologne). J. Inorg. Nucl. Chem., 29: 863-4 (Mar. 1967).

The ^{238}U spontaneous-fission yield is reported for the 97-mass chain by isolating and counting ^{97}Zr. (UK)

21557 ON THE COLLECTIVIZATION OF ONE-PARTICLE TRANSITIONS IN ODD DEFORMED NUCLEI. Berlovich, E. E. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 5: 560-5(Mar. 1967). (In Russian).

Frequently one-particle E2 transitions in odd deformed nuclei are strongly enhanced (up to several orders of magnitude) with regard to the Nilsson unity. M1 transitions are somewhat enhanced also. In case of the transitions altering the spin by 1, the enhancements may well be explained by rotational admixtures due to the Coriolis interaction. The observed sometimes enhancements

of the E2 transitions altering the spin by 2 may by involved by admixtures of γ-vibrational states. (auth)

21558 STRUCTURE OF THE GROUND AND EXCITED STATES IN ODD DEFORMED NUCLEI IN THE ACTINIDE REGION. Malov, L. A.; Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 566-72(Mar. 1967). (In Russian).

The interaction of quasiparticles with quadrupole and octupole phonons in deformed odd nuclei in the actinide region is calculated on the basis of the approximate second quantization method. This interaction leads to the production of low-lying collective nonrotational levels and levels with a complicated structure. In the given region of nuclei β-vibrational and octupole phonons are more important than in the rare-earth region. The agreement with the experimental data is good. (auth)

21559 MASS AND KINETIC ENERGY DISTRIBUTIONS OF FRAGMENTS FROM ^{233}U FISSION INDUCED BY THERMAL AND FAST NEUTRONS. Senchenko, V. I.; Tarasko, M. Z.; Mikhailov, V. B.; Kuzminov, B. D. Yadern. Fiz., 5: 514-17(Mar. 1967). (In Russian).

Mass and kinetic energy distributions of fragments from ^{233}U fission by thermal neutrons and by neutrons with energies of 1, 5.6, 6, and 7 MeV were measured. At the fast neutron induced fission, the fragment kinetic energies at heavy fragment masses 124 to 134 decrease and those for fragment masses greater than 144 increase. The dispersion maximum moves from 120 to 124 mass value. The yield ratio for symmetrical fragments in the fission induced by 5.6-MeV neutrons and by thermal neutrons is about 7. (auth)

21560 NEW DATA ON THE α DECAY OF ^{233}U. Baranov, S. A.; Gadzhiev, M. K.; Kulakov, V. M.; Shatinskii, V. M. Yadern. Fiz., 5: 518-26(Mar. 1967). (In Russian).

The α spectrum of ^{233}U was investigated in detail using a large magnetic α spectrograph. 31 α groups were observed, 19 of which were found for the first time. The energy level scheme of ^{229}Th was constructed using the experimental data. The analysis of the results made it possible to predict the existence of at least six rotation bands in ^{229}Th with the quantum characteristics $5/2^+$[633], $7/2^-$[743], $5/2^-$[752], $1/2^+$ and probably $3/2^+$[631], and $5/2^+$[622]. (auth)

21561 STRUCTURE OF THE FRAGMENT KINETIC ENERGY SPECTRA AT FISSION OF ^{235}U BY FAST NEUTRONS. Artem'ev, Yu. M.; Baranov, I. A.; Belyanin, Yu. I.; Gromov, A. V.; Protopopov, A. N.; Shiryaev, B. M. Yadern. Fiz., 5: 527-8(Mar. 1967). (In Russian).

The fragment kinetic energy spectra in the fission of ^{235}U by 14.9-MeV neutrons were measured for three fixed values of the light fragment energy using a double ionization chamber. The spectra obtained are found to have the structure due to the prevalent yield of the fragments with the mass numbers 139 to 140, 145 to 146, and 150 to 151. (auth)

21562 (n,nf) REACTION AND YIELD OF RETARDED NEUTRONS FROM ^{232}Th. Maksyutenko, B. P.; Pyshin, V. K.; Tarasko, M. Z. Yadern. Fiz., 5: 529-30(Mar. 1967). (In Russian).

The yield ratios for the delayed neutron clusters from ^{232}Th were measured at 5.0, 6.0, 6.2, 6.4, 6.6, 6.8, 7.25, 7.5, and 7.75 MeV. A strong dependence of the cluster yield ratios on the neutron energy was observed. (D.C.W.)

21563 FISSION OF URANIUM BY ELECTRONS WITH ENERGIES FROM 35 TO 260 MeV. Ranyuk, Yu. N.; Sorokin, P. V. Yadern. Fiz., 5: 531-4(Mar. 1967). (In Russian).

The ratios of photofission cross sections to electrofission cross sections were measured for uranium nuclei bombarded by electrons with energies from 35 to 260 MeV. On the basis of the results obtained, the fission of uranium is shown to be due to the absorption of dipole (E1 or M1) photons. (auth)

21564 PRODUCTION OF THE SPONTANEOUSLY FISSILE ISOMERS ^{240}Am AND ^{242}Am IN NEUTRON TRANSFER REACTIONS. Gangrskii, Yu. P.; Gvozdev, B. A.; Markov, B. N.; Polikanov, S. M.; Yungklaussen, G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 535-7(Mar. 1967). (In Russian).

The neutron transfer reactions producing the spontaneously fissile isomers ^{240}Am and ^{242}Am are investigated. ^{241}Am and ^{243}Am targets are bombarded with ^{22}Ne ions accelerated in the cyclotron up to energies of 120 to 150 MeV. The spontaneously fissile isomers are observed in the pick-up reactions only, i.e., when the neutron passes from a target nucleus to an incident nucleus (the reaction cross section amounts to 10^{-31} cm^2, and the isomer ratio to 10^{-5} cm^2). In case of inverse reactions (a neutron passes to a target nucleus), the isomer ratio is less by an order of magnitude at any rate. (auth)

21565 FRAGMENT ANGULAR DISTRIBUTION AND DEUTERON-INDUCED FISSION CROSS SECTION OF ^{226}Ra. Dovgilenko, A. S.; Zhagrov, E. A.; Nemilov, Yu. A.; Selitskii, Yu. A. Yadern. Fiz., 5: 538-43(Mar. 1967). (In Russian).

The fission cross section of radium is found to increase from $6 \pm 1.5 \cdot 10^{-32}$ cm^2 to $3.2 \pm 0.5 \cdot 10^{-26}$ cm^2 with the deuteron energy from 5 to 12.5 MeV. The measurements of the fragment energy spectra by semiconductor detectors at 90 and 175° to the incident deuteron direction show that the fragment angular distributions corresponding to the asymmetrical and symmetrical fission peaks are identical to 7% accuracy. (auth)

21566 ON THE DECAY OF ^{146}Eu. Avotina, M. P.; Grigor'ev, E. P.; Zolotavin, A. V.; Sergeev, V. O. (Leningrad State Univ.). Yadern. Fiz., 5: 465-70(Mar. 1967). (In Russian).

The conversion electron spectrum from ^{146}Eu was investigated with two β spectrometers of the type $\pi\sqrt{2}$ with 0.1 to 0.2% resolution. Using the proton resonance method one is able to determine energies of γ transitions with 0.05% accuracy. The intensive 634-keV transition in found to be composite and to consist of two transitions: 633.4 keV (E1) and 634.2 keV (E2). The transitions at 665, 705, and 901 keV are found to be doublet also. From the results obtained, the excited levels of ^{146}Sm are established: 747.4 (2^+); 1380.8 (3^-); 1381.6 (4^+); 1648 (2^+); 1812 (6^+); 2046 (4^+); 2084, 2157 (2^+) keV, and a number of high-lying levels as well. The position of the first excited levels ^{146}Sm with the quantum numbers 2^+, 3^- and 4^+ is compared with the analogous levels in some near even-even nuclei. (auth)

21567 INVESTIGATION OF NEUTRON RESONANCES IN ^{165}Ho. Karzhavina, E. N.; Popov, A. B.; Yazvitskii, Yu. S.; Efimov, V. N.; Shirikova, N. Yu. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 471-82(Mar. 1967). (In Russian).

Data are presented on the parameters of resonances in ^{165}Ho obtained using the neutron spectrometer in the LNP JINR. The parameters Γ and $g\Gamma_n$ are obtained for 17 levels in the region up to 110 eV, and the values $g\Gamma_n$ for 50 levels in the region 110 to 500 eV. The strength function $S_0 = 1.9 \pm 0.3 \times 10^{-4}$ and the value $\overline{\Gamma}_\gamma = 71 \pm 3$ MeV are determined, using the parameters obtained. (auth)

21568 ISOTOPIC SHIFTS OF THE K_{α_1} LINES IN THE INTERMEDIATE REGION BETWEEN SPHERICAL AND DEFORMED NUCLEI. Sumbaev, O. I.; Petrovich, E. V.; Zykov, V. S.; Ryl'nikov, A. S.; Grushko, A. I. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 5: 544-51(Mar. 1967). (In Russian).

The isotopic shifts of K_{α_1} lines in Nd isotopes and Sm isotopes were measured. The method based on the alternative insertion of compared isotopes into the viewing field of diffraction spectrometer with condensed aperture aberration was used. The data obtained make it possible to trace how the isotopic shift of Roentgen lines varies with the nucleus deformation in the region where nuclei lose the spherical symmetry. The comparison of these data with those found before from the isotopic shifts of optical lines is carried out. (auth)

21569 CHANNEL ANALYSIS OF THE NEUTRON-INDUCED FISSION OF ^{234}U. Vorotnikov, P. E. Yadern. Fiz., 5: 583-90(Mar. 1967). (In Russian).

The results of the channel analysis of the neutron-induced ^{234}U fission are given for energies from 150 to 1100 keV. The fission is shown to proceed mainly through negative-parity states of the intermediate nucleus ^{235}U. At the same excitation energy the fission width of states with negative parity is more than that of states with positive parity by two orders approximately; this fact may be due to the character of the nuclear deformation. The results of the analysis show that the height of the fission barrier is essentially more than it is now assumed to be. The fission near the threshold and something higher seems to have an under-barrier character. The fission probability is strongly influenced by quasi-stable states of the fissile nucleus. (auth)

21570 DECAY OF ^{106g}Ag AND ^{106m}Ag. Strutz, Klaus-Dieter (Univ., Goettingen, Ger.). Z. Phys., 201: 20-32(1967). (In German).

The decays of the 25-min ^{106g}Ag and 8.3-day ^{106m}Ag were investigated using Ge(Li) and Si(Li) counters. The γ rays of 17 transitions in the ^{106g}Ag decay and of 42 transitions in the ^{106m}Ag decay were observed, and their energies and relative intensities were determined. The intensities of these γ rays and the intensities of conversion electrons known from earlier measurements allow the determination of K conversion coefficients for 23 transitions. The present data are consistent with a level-scheme of ^{106}Pd having states at 0, 0^+; 511.8, 2^+; 1127.8, 2^+; 1133.1, 0^+; 1228.8, 4^+, 1557.4, 3^+; 1562, 2^+; 1702.8, 4^+; 1931.7, 3, 4^+; 2002, 0^+; 2040.4, 3, 4^+; 2076.8, 3, 4^+; 2084.2, 3^-; 2305.7, 4^-; 2324, 1, 2^+; 2350.4, 3, 4^+;

2365.3, 3, 4+; 2529, 1, 2+; 2756.3, 5+; and 2951.3 keV, 5+. The level-scheme of ^{106}Pd is compared with the predictions of the vibrational model for spherical nuclei. (auth)

21571 GAMMA QUANTA FROM RADIATION CAPTURE OF RESONANCE AND FAST NEUTRONS (A SURVEY). Bakov, A. T.; Kazanskii, Yu. A. pp 156-63 of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei. Vypusk 2. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The literature published before January 1964 on the spectra of γ quanta from radiation capture of fast neutrons is reviewed. The causes for variations in these spectra and the available experimental data are summarized. Requirements are formulated for studying radiation-capture γ quanta from the standpoint of shielding design. All variations in γ-quanta spectra are greatest for the hard radiation region. Where the intensity of the transition to the ground state is high, fluctuations alter the remaining portion of the spectrum. Contrary to expectations the spectra of capture γ quanta in almost all experiments are practically independent of neutron energy in the 30- to 500-keV range. The considerable differences between the spectra of capture γ quanta on various resonances as well as the differences between these spectra and those resulting from capture of thermal neutrons make it necessary to measure the averaged spectra of γ quanta on several resonances. These measurements should be made with incident neutron spectra of the form $1/E_n$ and with rather thick specimens for averaging with respect to neutron spectra that are close to those established in the material being studied. Much of the literature on the spectra of γ quanta from capture of nonthermal neutrons has no practical application for comparison of the necessary group spectra of capture γ quanta since the measurements are qualitative (do not indicate the number of γ quanta per capture). A table is given summarizing the experimental data on the absolute yield of γ quanta from radiation capture of neutrons with various energies. (ATD)

21572 DETERMINATION OF THE g-FACTOR FOR THE LOWEST 2^+ ROTATIONAL STATE OF ^{164}Dy BY THE MOESSBAUER METHOD. Muenck, E.; Huefner, S.; Quitmann, D. (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch., 21a: 2120-1(Dec. 1966). (In German).

Using the Mössbauer technique, the magnetic hyperfine splitting of the 73.4-keV γ ray of ^{164}Dy was measured in Al–Dy garnet at 4.2°K with a $HoAl_2$ source. A value of $g^{164}(73.4\ keV) = 0.331 \pm 0.016$ was obtained. (auth)

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Refer also to abstracts 19945, 21128, 21250, 21305, 21413, 21417, 21426, 21437, 21438, 21440, 21443, 21488, 21501, 21537, and 21569.

21573 (ISS–66/37) SOME RESULTS OF THE MONTE CARLO CALCULATION OF THE (e,e'p) REACTION FOR INCIDENT ENERGIES BETWEEN 300 AND 600 MeV. Farchi, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Oct. 10, 1966. 48p. Dep. mn.

Some calculations of experimental parameters for coincidence studies of (e,e'p) reactions are summarized. Tables referring to possible choices of experimental parameters are included. The calculations were made assuming that the reaction is a direct reaction and that the recoiling nucleus does not take part in the reaction. (D.C.W.)

21574 (ISS–66/45) LE REAZIONI A(e,e'x)R IN APPROSSIMAZIONE IMPULSIVA. (The A(e,e'x)R Reactions in Impulse Approximation). Frullani, S. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisicia). Nov. 18, 1966. 51p. (In Italian). Dep. mn.

The processes (e,e'x) in which high-energy electrons induce knockout reactions on nuclei ejecting the x sub-unity (nucleon or cluster) are studied. The cross-section formula in the impulse approximation is deduced, in the most general case, without the coplanar events restriction. A brief survey of formal theory of scattering is also presented. (auth)

21575 (JINR-P4–3174) O ROLI VIRTUAL'NYKH PEREKHODOV V UPRUGOM RASSEYANII ELEKTRONOV NA YADRAKH. (On the Role of Virtual Transitions in Elastic Scattering of Electrons on Nuclei). Petkov, I. Zh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 8p. (In Russian). Dep. mn.

The contribution of virtual transitions to elastic scattering of electrons is estimated in the framework of the vibrational model. This contribution is measurable in the region of a second diffraction cross-section minimum and at large scattering angles. (auth)

21576 (N–66-27440) ON THE A, T-DEPENDENCE OF COULOMB ENERGIES. Hecht, K. T. (Michigan Univ., Ann Arbor. Dept. of Physics). 1965. Contract Nonr-1224(59). 11p. (CONF-660306–25; AD–630886). CFSTI $3.00 cy, $0.65 mn.

From American Physical Society, Conference on Isobaric Spin, Tallahassee.

The five-dimensional quasispin formalism was used to extract the A, T-dependent factors of the Coulomb energy (diagonal matrix elements) in states of low reduced isospin. In particular, in a simple configuration j^n and states with seniority $v = 0$ ($t = 0$) and $v = 1$ ($t = 1/2$), the isovector and tensor parts of the Coulomb energy are given. (auth)

21577 (NP–16448) TEORETICHESKII ANALIZ REAKTSII VYBIVANIYA. (Theoretical Analysis of Knocking-Out Reaction). Report No. 438. Kolybasov, V. M.; Smorodinskaya, N. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 24p. (In Russian). Dep. mn.

The differential cross sections of the (p,2p) reactions calculated in the pole approximation are compared with almost all available experimental data at 155 MeV, 185 MeV, and 450 MeV. The proton widths of the light nuclei obtained from the (p,2p) reactions are compared with those obtained from stripping or pick-up reactions. While considering the (p,pn) and (π^-,π^-n) reactions the conditions are indicated under which the simple method based on the notion of the effective number of nucleons in the nucleus is applicable for the analysis of those reactions. (auth)

21578 (RISO–146) SCREENING CORRECTIONS IN THE SPIN ZERO APPROXIMATION. Eman, B. (Danish Atomic Energy Commission, Risoe. Research Establishment). Nov. 1966. 14p. Dep. mn.

Corrections for screening in beta decay are calculated from the solutions of the Klein–Gordon equations with Hulthén and Coulomb potentials. The parameters of the Hulthén potentials are obtained by fitting to the Hartree curves and the Fermi–Thomas–Dirac potentials, respectively. (auth)

21579 (TID–23787) ENERGY DEPENDENCE OF AVERAGE DIRECT REACTION CROSS SECTIONS AND PARTIAL NUCLEAR LEVEL DENSITIES. Technical Report No. 629. Griffin, James J. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Oct. 1966. Contract AT(40-1)-3491. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The possibility of studying partial level densities by measuring the energy dependence of average cross sections for direct reactions is pointed out. The (α,p) reaction is discussed, in particular; and a comparison of calculation and experiment is presented as an illustrative example. (auth)

21580 (UCRL–14627-T) NUCLEON–NUCLEON PHASE SHIFT ANALYSES BY CHI-SQUARED MINIMIZATION. Arndt, Richard A.; MacGregor, Malcolm H. (California, Univ., Livermore. Lawrence Radiation Lab.). Dec. 1965. Contract W-7405-eng-48. 74p. DTIE.

Various aspects of the problem of chi-squared minimization are discussed. Using nucleon-nucleon scattering as an example of a typical experiment to be analyzed, it is shown how one is essentially forced into using a chi-squared analysis. This is due to the nonlinearities inherent in the mathematical description of the problem. The importance of computers in this type of analysis is discussed. (S.F.L.)

21581 (ORNL-tr–1518) CALCULATION OF ENERGY SPECTRA FROM CONTINUOUS PULSE HEIGHT SPECTRA. PART II. Futtermenger, W.; Wueneke, C.-D. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report ABS-THH–1012. 62p. DTIE.

A method for the derivation of data necessary for the calculation of gamma energy spectra from pulse-height spectra for treatment on a computer is discussed. This includes the formation of unfolding matrices, preparation of measured pulse-height spectra, and calculation of flux or dose values from energy spectra. The performance of the calculation by computer is also discussed. (S.F.L.)

21582 LECTURES IN THEORETICAL PHYSICS. VOLUME VIII C. NUCLEAR STRUCTURE PHYSICS. Lectures Delivered at the Summer Institute for Theoretical Physics, University of Colorado, Boulder, 1965. Kunz, P. D.; Lind, D. A.; Brittin, W. E. (eds.). Boulder, Colo., University of Colorado Press, 1966. 682p. $9.00.

A series of lectures is presented on the following aspects of nuclear structure physics: nuclear spectroscopy via pickup reactions for nuclei with A = 48 to 62; wave functions and energy levels in the shell model; theory of direct nuclear reactions; collective and single-particle aspects of deformed nuclei; Hartree-

Fock theory; fluctuation phenomena in nuclear reactions; scattering of strongly absorbed particles; direct reactions and nuclear spectroscopy; theory of Rutherford scattering; many-body theory of intermediate structure; reaction theory of intermediate resonances for nucleon-nucleus scattering; and shell-model theory of identical nucleons. (S.F.L.)

21583 EVALUATION OF THE SECOND-ORDER ENERGY SHIFT. Bhaduri, R. K.; Peierls, R. E.; Tomusiak, E. L. (Oxford Univ.). Proc. Phys. Soc. (London), 90: 945-51(Apr. 1967).

The usual sum over intermediate states occurring in the expression for the second-order correction to the energy of a system of particles, such as a light nucleus, is reduced to solving a few inhomogeneous differential equations. A method of easily handling the Pauli principle, which occurs as a projection operator in the inhomogeneous terms, is introduced. If oscillator states are used as the unperturbed basis states, all differential equations become essentially one-body equations. (auth)

21584 ON THE APPLICATION OF GREEN FUNCTION TECHNIQUES TO FOUR-BODY CORRELATIONS IN NUCLEI. Bhagavan, M. R.; Edwards, S. F. (The Univ., Manchester, Eng.). Proc. Phys. Soc., (London), 90: 953-83(Apr. 1967).

A Green function method was devised to treat the effect, in a nucleus, of four nucleons coupling to zero momentum (quadrupling). The method permits the computation in the respective contributions by the quadruples and the pairs to the energy gap in nuclear spectra. A rough numerical estimate shows that the quadrupling gap is considerably larger than the pairing gap and is in good agreement with the experimental values for the energy gaps in light nuclei. (auth)

21585 SHAPES OF BETA SPECTRA. Paul, Helmut (Brookhaven National Lab., Upton, N. Y.). Nucl. Data, Sect. A, 2: 281-98(Sept. 1966).

A compilation of information on the measured shapes of beta spectra is given. It contains, whenever possible, the numerical coefficients describing the "correction factor," $C(W) = N_m(W)/N_{th}(W)$, where $N_m(W)$ is the measured energy spectrum and $N_{th}(W)$ is an appropriate theoretical energy spectrum. The information was collected from publications that data roughly between 1957 and July 1966. (auth)

21586 ON THE TEST OF T-INVARIANCE IN ELASTIC SCATTERING OF ELECTRONS FROM POLARIZED DEUTERONS. Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg). Z. Phys., 201: 99-104(1967).

An additional (magnetic) form factor G_2 which violates T-invariance is introduced in the electromagnetic vertex of the deuteron. This additional interaction yields a right-left asymmetry in the scattering of electrons from polarized deuterons. For our numerical evaluations we used values of G_2 which are consistent with the deviations from the impulse approximation found in measurements of the unpolarized cross section. A maximum asymmetry of approximately 40% was obtained at $q = 3.5\ f^{-1}$. However, care must be taken in the preparation of the polarized target, as a suitable tensor polarization may also produce asymmetry. (auth)

21587 SUBTRACTION IN POTENTIAL SCATTERING. Aly, H. H. (American Univ., Beirut); Wit, R. Z. Phys., 201: 129-33 (1967).

A general discussion is given for the validity of Cauchy's formula (with a finite number of subtractions) for the partial wave scattering amplitudes in the case of singular potential. (auth)

21588 NOTE ON PAIR PRODUCTION IN THE GIANT RESONANCE REGION. Ron, A.; Rose, M. E. (Univ. of Virginia, Charlottesville). Phys. Lett., Part B, 24: 372-3(Apr. 17, 1967).

The process of pair production by a decaying nucleus, excited by the incident photon, and the interference between this and the process of pair production by the incident photon in the field of the nucleus are considered. It is found that the nuclear contributions are pronounced for large scattering angles but the cross sections there are quite small. For forward scattering, the Bethe–Heitler cross section is dominant. (auth)

21589 VARIATIONAL PRINCIPLE FOR THE INTENSITY OF FORBIDDEN TRANSITIONS. Dmitriev, Yu. Yu.; Yur'ev, M. S. Vestn. Leningr. Univ., No. 16, Ser. Fiz. Khim., No. 3, 26-9(1966). (In Russian).

A new variational principle for the calculation of the intensity of forbidden transitions is given. The matrix elements for this transition and the upper and lower boundaries of the matrix elements are discussed. (S.F.L.)

21590 ANGULAR DISTRIBUTIONS OF GAMMA RAYS IN TERMS OF PHASE-DEFINED REDUCED MATRIX ELEMENTS. Rose, H. J.; Brink, D. M. (Oxford Univ.). Rev. Mod. Phys., 30: 306-47(Apr. 1967).

The theory of angular distributions of γ rays is developed systematically, aiming at a phase consistent derivation of angular distribution formulas for gamma rays emitted in the decay of an aligned initial state. The development starts from first principles, that is, the angular distribution formulas are derived directly from perturbation theory and all quantities introduced are carefully and explicitly defined. In particular the mixing ratios are phase consistently related to reduced matrix elements of interaction multipole operators which again are well defined in phase. Hence the mixing ratios become physical quantities which can be extracted from angular distribution measurements and then compared in both magnitude and sign with the predictions of nuclear models (especially the independent particle model). Critical stages in the theoretical development at which either a choice of phase convention has to be made or transformation properties enter are emphasized. As a first step, the transition probability for emission of gamma radiation with wave vector k and polarization ϵ from an initial state $|\lambda>$ to a final state $|\mu>$ is calculated using time-dependent perturbation theory. This step makes no specification of the angular momentum of the initial and final states and no multipole expansion of the interaction. Particular attention is paid to the relation between emission and absorption. In the second step of the calculation the angular momentum of the initial and final states is specified, the interaction is expanded in a series of multipoles and the final angular distribution formula is derived. In order to describe emission of gamma radiation a definite and well-defined part of the interaction Hamiltonian must be expanded. This part of the Hamiltonian must be expanded. This part of the Hamiltonian is determined by the order in which the initial and final states are written in transition matrix elements. The expansion yields a set of interaction multipole operators which are well defined in phase and transformation properties. There is no uncertainty in the relative phase of the electric and magnetic interaction multipole operators due to an arbitrariness in the phases of the vector potentials. These interaction multipole operators must be used to define the mixing ratios appearing in angular distribution formulas. It is shown that care must be taken when using Siegert's theorem and "effective" multipole operators. In the last section, reduced matrix elements of the interaction multipole operators are given explicitly for one- and two-particle states and one- and two-holes states of the independent-particle model. (auth)

21591 S-WAVE NEUTRON STRENGTH FUNCTIONS. Seth, Kamal K. (Northwestern Univ., Evanston, Ill.). Nucl. Data, Sect. A, 2: 299-32(Sept. 1966).

The concept of neutron strength functions and the experimental methods of measuring them are reviewed briefly. S-wave neutron strength functions, S(0), obtained from experimental data on neutron total cross sections at energies below 700 keV are presented in tabular form. Publications and private communications published between 1954 and July 1966 have been covered. Recommended values of S(0) are listed and are plotted as a function of atomic weight. Theoretical predictions based on the nuclear optical model are also presented for purposes of comparison. (auth)

21592 SIMPLE DENSITY DEPENDENT EFFECTIVE INTERACTION. Green, A. M. (Princeton Univ., N. J.). Phys. Lett., Part B, 24: 384-6(Apr. 17, 1967).

A density-dependent modification of the Kallio-Kolltveit potential is made to ensure a good fit to nuclear matter. With the resulting effective interaction, various matrix elements typical of the ^{16}O region are evaluated, and a comparison is made with the results of Wong and Kuo. (auth)

21593 FISSION IN A SHELL MODEL. Harvey, M. (Chalk River Nuclear Labs., Ontario). Phys. Lett., Part B, 24: 374-6 (Apr. 17, 1967).

A possible simple way to describe the fission phenomena in terms of an independent-particle model is pointed out. Only consider such properties as the minimum energy to fission (i.e., of splitting into two parts) and the masses of the fission fragments are considered. (auth)

21594 DIRECT CALCULATION OF NUCLEAR STRUCTURE FROM THE TWO-NUCLEON PHASE SHIFTS. Elliott, J. P.; Mavromatis, H. A.; Sanderson, E. A. (Univ. of Sussex, Eng.). Phys. Lett., Part B, 24: 358-60(Apr. 17, 1967).

A method is presented for obtaining directly from the experimental phase shift the matrix elements $\langle n's\,l'j|V|n\,s\,l\,j\rangle$ between oscillator wave functions of the relative motion without constructing an explicit potential. The matrix elements calculated in this manner are similar numerically to those obtained with the Tabakin potential. A calculation of spin-orbit splittings in several nuclei using this method shows good agreement with experiment. (auth)

21595 SHAPE OF HEAVY NUCLEI. Siemens, Philip J.; Bethe, H. A. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 18: 704-6(Apr. 24, 1967).

The binding energies of systems of very many nucleons in several geometric configurations were studied using the Bethe-Weiszacker semi-empirical mass formula. The configurations considered were a spherical shell, and oblate and prolate spheroids. It was found that, for beta-stable nuclei with more than 104 protons, the most energetically favorable configuration is a prolate spheroid. (D.C.W.)

21596 INTERMEDIATE RESONANCES OF NEUTRONS SCATTERED BY DEFORMED NUCLEI. Pisent, G.; Zardi, F. (Univ., Padua). Nuovo Cimento (10), 48B: 174-7(Mar. 11, 1967).

The excitation of collective states by the scattering of neutrons from permanently deformed even-even nuclei is considered. The collective properties of the target are described in the framework of the phenomenological theory developed by Bohr and Mottelson. The schematizations introduced in writing down the wave function and the Hamiltonian are those familiar to the coupled-channel techniques, but the physical interpretation and mathematical manipulation of the equations are those suggested by Feshbach's doorway-state theory. (S.F.L.)

21597 ELASTIC SCATTERING OF POLARIZED NUCLEONS ON NUCLEI. Van Der Woude, A. (Rijksuniversiteit, Groningen, Netherlands). Ned. Tijdschr. Natuur., 32: 347-67(Nov.-Dec. 1966). (In Dutch).

The experimental techniques used for the measurement of the elastic scattering of polarized nucleons on nuclei are described. The significance of the parameters of the optical potential is discussed and some results of the scattering theory are reported. Some experimental results are described. The extent to which a systematic description of the elastic scattering with the optical model is possible is considered. (J.S.R.)

21598 INFLUENCE OF THE l-SPACE LOCALIZATION OF STRIPPING REACTIONS ON THEIR ANGULAR DISTRIBUTIONS. Abul-Magd, A. Y. (Atomic Energy Establishment, Cairo). Phys. Lett., 24B: 325-8(Apr. 3, 1967).

A simple expression is obtained for the differential cross sections of stripping reactions by making use of the l-space localization of these reactions. (auth)

21599 TWO-NUCLEON INTERACTIONS IN AN IRREDUCIBLE FORM; CALCULATION OF THE BINDING ENERGY IN LIGHT NUCLEI. Vanagas, V. V.; Petrauskas, A. K. (Inst. of Physics and Mathematics, Vilnyus, USSR). Yadern. Fiz., 5: 552-9(Mar. 1967). (In Russian).

The single-particle and two-particle operators are expressed in an irreducible form with respect to the symmetrical group. The matrix elements of the kinetic energy, and the Coulomb and central two-nucleon interaction operators are expressed as a sum over products of orbital submatrices and certain coefficients, depending on the symmetry properties. The properties of these coefficients and the orbital submatrices are discussed in the case when the wave function is given in the Wigner supermultiplet approximation. The binding energy of a nucleus, the ground states of which can be described by a wave function with the orbital Young pattern [44 . . . 4k] (k = 0, 1, 3), is calculated semiempirically, taking nonsymmetrical terms into account. (auth)

21600 TIME OF THE COLLISION IN NUCLEAR REACTIONS. Rybachenko, V. F. Yadern. Fiz., 5: 685-7(Mar. 1967). (In Russian).

Various proposed experiments to determine the time of the collision in binary nuclear reactions are considered for arbitrary interactions between the particles. Expressions are given for the time of the collision. (auth)

21601 PHYSICS OF NEUTRINOS. Nagy, Karoly. Magyar Tud. Akad. Mat. Fiz. Tud. Osztalyanak Kozlem., 16: 413-21(1966). (In Hungarian).

A review of neutrino physics is presented with emphasis on the prediction, and subsequent experimental verification, of its existence. (D.C.W.)

21602 THE n–n SCATTERING LENGTH, THE THREE-BODY PROBLEM AND CHARGE SYMMETRY. Okamoto, K.; Lucas, C. (Univ. of New South Wales, Kensington, Australia). Nuovo Cimento (10), 48A: 233-6(Mar. 1, 1967).

It is pointed out that the evidence for charge symmetry and charge asymmetry for nuclear forces are not necessarily inconsistent. It is found that the discrepancy between the Coulomb energy of ^{3}He and the binding energy difference between ^{3}H and ^{3}He can reasonably be explained by charge-asymmetric nuclear forces due to electromagnetic mixings of various mesons, and is also consistent with the experimental data on the n–n scattering length. (J.F.P.)

21603 MOMENT OF INERTIA OF THE COMPOUND NUCLEUS. Erba, E, Gadioli; Sona, P. G. (CISE, Milan. Univ., Milan). Energ. Nucl. (Milan), 14: 111-12(Feb. 1967).

In the statistical theory of the distribution of the angular momentum among the excited levels of nuclei, the formula $\langle L^2 \rangle = 2TI$ is commonly used, where L is the orbital part of the total angular momentum, T is the temperature, and I is the rigid-body value of the moment of inertia. This formula is shown to have a more general validity, in the classical limit, than is usually assumed. The formula is derived from classical statistical mechanics for an arbitrary many-body potential depending only on the coordinates, including the case where the value of I varies considerably with the temperature, showing that the validity of the formula is not affected by possible strong dilation of nuclear matter at high excitations. (S.F.L.)

21604 ON THE STRUCTURE OF THE GALILEAN AND TRANSLATIONALLY INVARIANT OPERATOR ALGEBRA DESCRIBING INTRINSIC PROPERTIES OF FINITE NUCLEAR SYSTEMS. Seyfferth, Siegfried (Univ., Goettingen, Ger.). Z. Phys., 200: 511-25(1967).

The structure of the Galilean and translationally invariant operator algebra for finite systems of fermions is investigated. After performing the decomposition of the Fock space into Hilbert spaces for the center-of-mass motion and the intrinsic motion, intrinsic field operators are defined; and their commutation relations are established. These relations deviate in a certain particle number-dependent way from the usual fermion relations. It is shown that the operators corresponding to the intrinsic (e.g., nuclear) observables can be represented in the familiar way, the usual field operators being replaced by the intrinsic ones. In this theory the normal shell model calculations appear as the approximation performed by treating matrix elements of nuclear observables as if the intrinsic field operators were satisfying the exact Fermi commutation relations. (auth)

21605 DYNAMIC POLARIZATION OF LIQUID ^{3}He. McAdams, H. H.; Walters, G. K. (Rice Univ., Houston, Tex.). Phys. Rev. Lett., 18: 436-8(Mar. 20, 1967).

Optical pumping of ^{3}He gas in diffusive contact with ^{3}He liquid at 0.93°K yielded a steady-state nuclear spin polarization of 0.085% in a 20-mm^3 liquid sample and transient polarization of 0.15% in a 2-mm^3 sample. The experiments were conducted in an applied magnetic field of about 8G, corresponding to a thermal equilibrium polarization of 7×10^{-5}%. Using the same technique, 2% polarization was observed in ^{3}He gas at 4-mm pressure and 0.93°K. (W.D.M.)

21606 INVESTIGATION OF THE NUCLEAR COLLECTIVE MODEL AND THE SCATTERING OF HIGH-ENERGY ELECTRONS FROM PARTIALLY ALIGNED NONSPHERICAL NUCLEI. Wright, Louis Edgar. Durham, N. C., Duke Univ., 1966. 135p.

Thesis.

The collective model Hamiltonian which is expected to be applicable to the nonspherical or deformed nuclei (i.e., nuclei which display rotational levels) is investigated theoretically. Particular emphasis is placed on the symmetries arising from the non-uniqueness of the collective description in the intrinsic coordinate system. The solutions corresponding to various interaction potentials describing even-even nonspherical nuclei are obtained and are compared to experiment. Also, the problem of high-energy electron scattering from partially aligned non-spherical odd-A nuclei is treated. Calculation of the differential cross section is performed by means of partial-wave analysis of the Dirac equation, and the scattering from the nonspherical part of the charge distribution is treated to first order in the nuclear deformation. Present calculations indicate that it is possible to determine the magnitude and the sign of the nuclear deformation by such electron scattering experiments. (Dissertation Abstr.)

21607 ANALYSIS OF NUCLEON–NUCLEUS SCATTERING WITH THE WKB METHOD. Lee, Hyang Key. East Lansing, Mich., Michigan State Univ., 1966. 169p.

Thesis.

The WKB method together with the impulse approximation is applied to the inelastic scattering of 156-MeV nucleons from the nuclei ^{12}C, ^{16}O, and ^{40}Ca. The optical potential employed includes a spin-orbit part. In general, the agreement between prediction and experiment for the cross sections is impressive. The predictions by the WKB compare favorably with the results of the DWIA, although the WKB appears to predict slightly larger cross sections than the DWIA. For normal parity states, the effect of the spin-orbit potential on the polarization is as expected. In the cases where spin-flip is important, the polarization is sensitive to the spin-orbit term. For ^{40}Ca, the imaginary part of the spin-orbit potential contributes little to the polarization. The WKB method is applied also to the cases where the incident energy of the projectile is 40 MeV. In place of the impulse approximation, a two-body potential of the Yukawa type is assumed. The agreement between data and prediction is qualitative only. The WKB is clearly inadequate at this low energy. (Dissertation Abstr.)

21608 PROCEEDINGS OF THE 2nd INTERNATIONAL SYMPOSIUM ON POLARIZATION PHENOMENA OF NUCLEONS, KARLSRUHE, SEPTEMBER 6–10, 1965. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966. 537p. sFr. 86.-. (CONF-650928).

Separate abstracts were prepared for 76 of the 102 papers included. The other 26 papers can be found under CONF-650928 in the report number index. (D.C.W.)

For abstracts of individual papers see: 19927–19929, 21337–21355, 21412–21430, 21448–21460, 21493–21499, 21547–21549, 21609–21619, and 21784.

21609 POLARIZATION FROM THE GENERALIZED OPTICAL POTENTIAL. Perey, F. G. (Oak Ridge National Lab., Tenn.). pp 191-202 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Optical-model predictions for the polarization in inelastic scattering are compared with experimental data. Scattering with the excitation of collective states is emphasized. It is shown that even with the use of diagonal potentials which fit well the differential elastic cross section and polarization, the collective model in which only the real part of the potential is deformed fails to reproduce the inelastic polarization and the spin-flip probability. (D.C.W.)

21610 POLARIZATION PHENOMENA IN STRIPPING AND PICK-UP REACTIONS. Goldfarb, L. J. B. (Univ. of Manchester, Eng.). pp 203-18 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A survey of recent developments in the interpretation of polarization effects in pickup and stripping reactions is presented with emphasis on (d,p) and (p,d) reactions. (D.C.W.)

21611 POLARIZATION PHENOMENA AND NUCLEAR STRUCTURE. Weidenmueller, H. A. (Univ., Heidelberg). pp 219-29 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The testing of the transformation properties of nuclear forces under P and T invariance by polarization experiments is discussed. The parameterization of scattering experiments by general invariance principles is then described, together with the resulting possibility of analyzing reaction mechanisms using polarized beams and targets. The investigation of nuclear structure by polarization experiments is discussed. (D.C.W.)

21612 INVESTIGATION OF THE SHAPE OF THE PROTON SPIN-ORBIT POTENTIAL. Goldfarb, L. J. B. (Univ. of Manchester, Eng.); Greenlees, G. W.; Hooper, M. B. pp 230-2 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The shape of the spin-orbit part of the optical-model potential was investigated. Cross-section and polarization data on the elastic scattering of 9.4-MeV protons by ^{59}Co, Cu, ^{58}Ni, and ^{60}Ni were analyzed using the optical model. (D.C.W.)

21613 CONTRIBUTIONS FROM THE D-STATE OF THE DEUTERON TO DEUTERON POLARIZATION IN (p,d) REACTIONS. Johnson, R. C. (Battersea Coll. of Tech., London). pp 223-4 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The effects of the d-state component of the deuteron wave function in (p,d) reactions are discussed. An expression for the d-state contribution to the second-rank components of the deuteron polarization is presented, considering the ^{9}Be(p,d)^{8}Be reaction as an example and using the plane-wave approximation. (D.C.W.)

21614 POLARIZATION IN ELASTIC NUCLEAR SCATTERING OF STRONGLY ABSORBED SPIN-½ PARTICLES. Frahn, W. E. (Univ. of Cape Town). pp 235-7 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Expressions for the differential cross section and the polarization in elastic scattering of strongly absorbed spin-½ particles are derived. (D.C.W.)

21615 ANALYSIS AND INTERPRETATION OF THE NEW NUCLEON–NUCLEON MEASUREMENTS NEAR 24 MeV. Noyes, H. P. (Stanford Univ., Calif.). pp 238-43 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The results of a phase-shift analysis of p-p and n-p scattering near 25 MeV are compared with the predictions of several potential models. It is noted that the inclusion of data obtained with polarized beams and polarized targets moves the T = 1 phases closer to the values predicted by the models. The predictions of certain models are compared with experimental data. (D.C.W.)

21616 GAMMA RADIATION FROM NUCLEI ORIENTED BY THE CAPTURE OF POLARIZED NEUTRONS. Michalec, R. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). pp 247-8 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

The orientation parameters of compound nuclei from the capture of polarized neutrons by an isolated nuclear resonance level with a given spin and parity are considered theoretically together with the angular distribution of the intensity and polarization of the gamma radiation from the compound nuclei. (D.C.W.)

21617 EXPERIMENTS ON POLARIZATION IN NUCLEAR STRIPPING REACTIONS. Miller, D. W. (Indiana Univ., Bloomington). pp 410-32 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Some polarization experiments on stripping reactions are discussed with emphasis on comparisons of experimental data with DWBA fits, where available. In some cases, a rather phenomenological viewpoint of the experimental results is adopted. (D.C.W.)

21618 POLARIZATION MEASUREMENTS AND NUCLEAR LEVELS. Darden, S. E. (Univ., Basel). pp 433-53 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A review of some polarization studies of compound-nuclear states formed in reaction and scattering processes is presented. 112 references. (D.C.W.)

21619 DIGITAL CORRECTION OF EXPERIMENTAL FAST-NEUTRON POLARIZATION DATA FOR FINITE-GEOMETRY AND POLARIZED MULTIPLE SCATTERING EFFECTS. Aspelund, O.; Gustafsson, B. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 475-8 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

A Monte Carlo program for the correction of fast-neutron data for finite geometry and polarized multiple scattering is briefly described. (D.C.W.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 19790, 19827, 19828, 19959, 20472, 21001, 21043, 21755, 21776, 21777, and 21793.

21620 (ACNP-65602) ELK RIVER REACTOR OPERATIONS ANALYSIS PROGRAM. Semi-Annual Progress Report, January 1, 1965-June 30, 1965. Fisher, J. R.; Kendrick, E. D.; Kruzic, T. P.; Schafer, A. C. Jr. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-1357. 86p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The reactor heat generated was 7434.8 MWd; and the net electrical generation was 67,362 MW-hr. The overall plant behavior was excellent, and plant availability was high. Operations analysis efforts have been directed mainly to establishing a fuel management program which best meets the objectives of the Elk River Reactor, analyzing the operation of the plant energy systems and the primary auxiliary systems, and studying methods for disposing of spent ion-exchange resins. The measured position of the center regulating control rod vs core exposure is compared with the previously reported curve of the predicted rod position. The observed rate of rod withdrawal shows no significant deviation from the calculated rate. Progress is reported on the fuel cycle studies in establishing fuel loading patterns for Core II which meet the requirements for stuck-rod shutdown margin and excess reactivity. The patterns which have received the most attention are based on a three-zone (most depleted fuel discharged) assumption. Plant energy transfer system data taken in March 1964 and March 1965 are compared with the design parameters. The differences are small and reflect an increased accuracy in the more recent data which is attributed mainly to better instrument calibration. Analyses of the primary purification system and the boron-poison system are also reported. A study of methods for disposal of spent ion-exchange resins resulted in the recommendation that resins be sluiced into a shielded disposable drum. Abstracts of reports from all sources which were issued during this report period are included. (auth)

21621 (AECL-2631(Rev.)) GRAPHS AND TABLES OF THE ISOTOPIC COMPOSITION OF PLUTONIUM PRODUCED IN CANADIAN D_2O MODERATED REACTORS. Halsall, M. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1967. 49p. (CRRP-1245(Rev.)). Dep. mn. CFSTI $3.00 cy, $0.65 mn. AECL $1.00.

The isotopic composition of irradiated natural U fuel has been calculated for the three reactors NPD, Douglas Point (CANDU-PHW) and Pickering, and also for a conceptual 18-rod fuel design in CANDU-BLW. Three sets of results are presented for each reactor. These correspond to operation at the design lattice pitch and also at pitches chosen to reduce and increase the moderator volume per cell by 20%. (auth)

21622 (AECL-2649) CALCULATION OF REACTIVITY COEFFICIENTS FOR A BLW LATTICE CELL. Townes, B. M.; Primeau, D. B.; Duret, M. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1966. 86p. (CRRP-1247; BLW-250-Note-56). Dep. mn. CFSTI $3.00 cy, $0.65 mn. AECL $2.00.

The increase in reactivity following a loss of coolant accident for a conceptual 19-element BLW lattice cell has been calculated using the LATREP, POOOF and METHUSELAH II computer programs. Results for reactivity coefficients and the variation of k_{eff} with burnup from these three programs are compared. The overall agreement between the predicted results is fair. Results of some subsidiary LATREP calculations are presented. Here the effect of the fudge factor, radial variations in coolant density, and a reduction in moderator density are investigated. Results are given for an 18-element BLW rod design. (auth)

21623 (AEEW-R-492) A FORTRAN PROGRAMME FOR DETERMINING FREQUENCY RESPONSES FOR LINEAR SYSTEMS WITH TIME DELAYS. Milsom, Peter R. (Atomic Energy Establishment, Winfrith (England)). Nov. 1966. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 3s. 6d.

A digital computer programme is described for evaluating frequency responses for systems with a large number of variables, such as nuclear reactors. In its standard form the programme is capable of determining the gain and phase of up to 35 variables over a range up to 30 frequencies for a system described by up to 65 equations. The equations must be either first order differential or algebraic, and either type may include time delayed terms. Up to 50 such terms are permissible throughout the equation set. Provision is made for up to 10 inputs and up to 50 differentiated input terms are permitted throughout the equation set. In punching the data from the equations the user has no sorting or arranging of coefficients to do, and the equations may be in any order. The specifying of other input information, such as frequency range, the inputs to be perturbed, and the variables for which frequency responses are required, is also very straightforward. (auth)

21624 (ANL-7202) THE ELECTRICAL DESIGN OF THE EBR-II. Verber, F.; Schmidt, H. L. (Argonne National Lab., Ill.). June 1966. Contract W-31-109-eng-38. 227p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The EBR-II electrical system was designed to achieve a high degree of reliability and continuity of power supply desirable for minimizing the number of reactor scrams and consequent thermal shocks to the fuel assemblies and other components of the reactor. Included in the design discussion are location and arrangement of electrical equipment in buildings and yard areas. Figures illustrate these layouts. The design and operational features of the underground duct system, grounding system, communication, and alarm systems are described. An accurate and useful record of the essential features of the EBR-II electrical design is provided. (L.C.L.)

21625 (APDA-300) SODIUM LEVEL DETECTORS IN THE ENRICO FERMI ATOMIC POWER PLANT. Reicks, G. H. (Atomic Power Development Associates, Inc., Detroit, Mich.). Nov. 30, 1965. Contract AT(11-1)-865. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two types of continuous level detectors are installed in the Enrico Fermi Atomic Power Plant to measure Na levels. One type is the Moore Special Model "15" bellows-type detector, and the other is the Taylor NaK-filled diaphragm detector. The Moore Special Model "15" detector measures levels with accuracies of approximately ±3 inches of reading. An advantage is that the detectors are capable of measuring levels with a cover gas pressure below atmospheric and, with the properly observed precautions, down to a full vacuum. The Taylor NaK-filled detector has operated satisfactorily with a high degree of accuracy, small temperature shift, good linearity and reproducibility, and with a minimum of maintenance required. Both of these detectors are difficult to install and shield properly as well as difficult to remove and replace once they are installed. They have moving parts which could create maintenance problems, and accessory instrumentation is required for remote calibration. Results of Fermi plant experiences with two types of level detectors leads to the conclusion that a design and development program for liquid-level detectors is needed for future liquid-metal systems. (auth)

21626 (APED-4856) REACTOR PRESSURE VESSEL O-RING AND FLANGE FACE OVERLAY MATERIALS. A SERIES OF SCREENING TESTS. Hackney, B. D.; McDaniel, C. J. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). May 1965. 154p. (65-APE-6).

Silver-plated, tubular, annealed Type-304 stainless steel O-rings have been employed as gaskets in APED head closures. Use of these O-rings, combined with a weld overlay deposit on vessel flange faces, has been the past approach to the reactor vessel head to shell seal. Flange face overlay deposit cracking, occurring in several reactor vessels in the past, has created a need to search for alternate materials for this application. A series of deflection tests has been conducted on several candidate O-ring and flange face weld overlay materials for the purpose of locating better materials prospects for the sealing application. The screening tests have resulted in the elimination of many of the original candidate O-ring and flange face overlay materials. The screening tests indicate that quarter-hard, Type-304 stainless steel, O-ring material, and Types-410 and -309 stainless steel and Inconel-718 Ni-base overlay materials should be further evaluated by simulated environmental tests. (J.R.D.)

21627 (AWRE-O-69/66) REP3: A SPATIALLY DEPENDENT FISSION PRODUCT POISONING CODE FOR THE IBM 7030. Brickstock, A.; Davies, A. R. (Atomic Weapons Research Establishment, Aldermaston (England)). Jan. 1967. 14p. Dep. mn. BIS $0.50. HMSO 2s. 6d.

A weighting function is used in the program to produce poisoning as function of time for any reactor operating sequence or shutdown sequence. Conventional space independent poisoning may also be calculated using the code. Running procedures, inputs and other information about the code are given. (J.R.D.)

21628 (CONF-651154-4) DOSIMETRIE EFFECTUEE AU CEN-GRENOBLE POUR LES BOUCLES A LIQUIDES ORGANIQUES DANS LE CADRE DU PROJET O.R.G.E.L. (Effecting Dosimetry at CEN-Grenoble for the Liquid Organic Loops in the

ORGEL Project). Mas, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov. 4, 1965. 10p. (In French). Dep. mn.

From Symposium on Flux Measurements used in Connection with Irradiation Equipment in Research and Material Test Reactors, Grenoble, France.

The dosimetry of the radiations responsible for the radiolysis of terphenyl is outlined. Flux integrator detectors were placed on the outside of the loops. The readings of the detectors are related to the mean flux in the irradiation vessel by the intermediary of measurements on a vessel mockup. The method used for the calculation of the energy depositions caused by γ and fast neutrons is outlined. Differential measurements made to establish a relation between $G_{neutron}$ and G_{γ} were made. The precision of the method for fast neutron flux is 4% and for the γ flux it is less than 5%. (J.S.R.)

21629 (CONF-660511--, pp 8.4.1-11) THE ORGANISATION AND ADMINISTRATION OF THE IRRADIATION PROGRAMME FOR THE FAST REACTOR DOUNREAY EXPERIMENTAL REACTOR ESTABLISHMENT. Jones, G. M. (United Kingdom Atomic Energy Authority, Dounreay (Scotland), Reactor Group).

The organization is designed to coordinate the design, development, and fabrication of test items using the skills of many specialists. Information and discussions are included on preparation of irradiation experiments, experiment data recording, and experiments developed and used for fast reactor work. (J.R.D.)

21630 (EUR-2773.e) FIRST TARGET PROGRAMME FOR THE EUROPEAN ATOMIC ENERGY COMMUNITY. ELECTRICITY PRODUCTION FROM NUCLEAR REACTORS. DOCUMENTARY ANNEX. STATUS OF AND OUTLOOK FOR NUCLEAR ENERGY IN THE EUROPEAN COMMUNITY. (European Atomic Energy Community). Mar. 1966. 360p. Dep. mn.

A summary of information concerning target programs in EURATOM for the period 1966 to 2000 is presented. Information is included concerning the first program and concerning the status and future of nuclear energy in the European community. (J.R.D.)

21631 (EUR-3260.i) CENTRALE ELETTRONUCLEARE DEL GARIGLIANO RELAZIONE ANNUALE 1965. (Garigliano Nuclear Power Plant Annual Report, 1965). (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Jan. 1967. 92p. (In Italian). Dep. mn.

During the period April 1965 to April 1966 the Garigliano Power Plant operated normally up to 24 September 1965, when it was shut down for scheduled maintenance and channel replacement. The plant was started up again on 1 May 1966. Operating data for the period from 1 April to 24 September 1965 and full information on the work carried out throughout the shut-down period are presented. (auth)

21632 (EURAEC-1618) CRITICAL INVESTIGATION ON STEADY BURNOUT. Progress Letter No. 1. (Applicazioni e Ricerche Scientifiche, Milan (Italy)). Apr. 12, 1966. Contract 073-65-11TEEI. 7p. (EUR-2831). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Preliminary work on an investigation of steady burnout of reactor fuels is discussed. Selections of simpler geometries and uniform heat flux distribution are justified. A computer program has been written to determine steam and water physical parameters and their effects on saturation line, heat balance equation, burnout heat flux, saturation power, and inlet quality corresponding to steam quality at outlet. (M.L.S.)

21633 (EURAEC-1734) STUDIES ON CYCLONES FOR STEAM SEPARATION IN BOILING WATER REACTORS. Quarterly Report No. 3, July 1-September 30, 1966. Tischer; Schueler; Brunswick (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergieanlagen). Contract 083-66-1-TEED. 54p. (EUR-3303). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Parallel behavior of two axial separators with axial mixture feed was studied. The possibility of arranging the axial cyclone in several rows and closely together in the reactor fall space to allow higher reactor outputs can be used without reservation only if even mixture division can be ensured. The measuring system used previously was extended for analysis of inflow conditions. In particular, the bubble content at the inlet to the cyclones was analyzed. Creation of uniform conditions in this respect will be a further task. (auth)

21634 (EURAEC-1770) HEAT TRANSFER AND FLUID FLOW CHARACTERISTICS IN A PRESSURIZED WATER REACTOR. Quarterly Progress Report No. 11, July 1-October 1, 1966. (Technische Hogeschool, Eindhoven (Netherlands)). Dec. 1966. Contract 011-64-1TEEN(RD). 19p. (EUR-3320). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Results of experiments are reported that were mainly connected with the calibration of the instrumentation of the mixing test section. The newly constructed impedance void gages have been calibrated against the γ-ray attenuation method. A theoretical study and the development of a computer program on the hydraulic coupling of parallel channels is being continued. Experiments were also carried out on a seven rod cluster element to determine the effects of the shroud distance and of the mixing between the fuel channel and surrounding channels on the burnout heat flux. (auth)

21635 (GEAP-5195) PRESTRESSED CONCRETE PRESSURE VESSELS FOR BOILING WATER REACTORS. Quarterly Report No. 4, April-June 1966. Boggio, G. (comp.) (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). July 1966. Contract AT(04-3)-189. 20p. (EURAEC-1731). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

A reference design of a 1000 MW(e) boiling reactor utilizing a prestressed concrete pressure vessel was completed during the period. Information is included concerning reference design work and vessel thermal insulation design progress. (J.R.D.)

21636 (HPR-70) DEVELOPMENT OF DIFFERENTIAL TRANSFORMERS FOR MEASUREMENT OF IN-CORE FUEL ELONGATION. Schenk, K. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Jan. 1967. 32p. Dep. mn.

A differential transformer capable of monitoring fuel canning elongations in-pile has been developed as a part of the HBWR in-core instrumentation development program. A description of the instrument and a survey of the instrument properties are presented. In view of the experience obtained to date various applications of the instrument can be foreseen. In-pile experiments to study the applicability of the instrument for burn out protection have been made and will be described in detail in another report of the HPR-series. (auth)

21637 (HPR-71) HBWR QUARTERLY PROGRESS REPORT, OCTOBER TO DECEMBER 1966. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Feb. 1967. 84p. Dep. mn.

A chronology of the activities of the Halden Boiling Reactor development and operation project is given. The operations summary is reported and includes operating statistics, test fuel assembly failures, IFA-28 fission gas pressure membrane failure, and chloride detection in the primary system. The research program includes reactor statics and reactor dynamics. In the development program, the fuel irradiation testing is summarized and burnout detector, neutron detector, γ thermometer, pressure transducer, and multiplexer developments are discussed. (J.C.W.)

21638 (IITRI-578P21-26) WATER DEPRESSURIZATION STUDIES. Zaker, T. A.; Wiedermann, A. H. (IIT Research Inst., Chicago, Ill.). June 1966. Contract AT(11-1)-578. 55p. (CONF-660650-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From European Nuclear Energy Agency CREST Meeting, Ispra, Italy.

Experiments have been conducted on rapid depressurization of a tube containing water at initial temperatures and pressures representative of those in pressurized-water nuclear reactors. The 2-in.-dia pressure tube is separated initially from an expansion section by a tempered-glass diaphragm. Transient pressure and temperature measurements and high-speed photographic observations have been made in the pressure tube during decompression initiated by diaphragm rupture. Several cases of pressure-tube blowdown have been analyzed theoretically for various initial conditions of pressure, temperature, and quality using the equilibrium thermodynamic properties of homogeneous two-phase mixtures. A detailed comparison of predicted pressures with the results of a typical blowdown experiment is presented. It is shown that certain features of the response, which have appeared to be in the nature of relaxation phenomena, may be explainable on the basis of nonuniformities in initial fluid conditions. A correlation has been found between the reaction impulse exerted axially on the ruptured pressure tube and the total enthalpy initially stored in the fluid. (auth)

21639 (JAERI-1118) EXPANDA-2: IMPROVEMENT OF THE EXPANDA, THE ONE-DIMENSIONAL DIFFUSION EQUATION CODE FOR FAST REACTORS. Suzuki, Tomoo; Katsuragi,

Satoru (Japan Atomic Energy Research Inst., Tokyo). May 1966. 17p. (In Japanese). Dep. mn.

The code EXPANDA has been improved, so that it can also treat the ABAGJAN group constants system including tables of resonance self-shielding factors, assembled in the U.S.S.R. For this purpose, the maximum number of energy groups and of groups for down-scattering were increased to 25 and 9 respectively and various options of calculation were added. The calculation of the breeding ratio, adjoint neutron fluxes, sodium-void coefficient, Doppler coefficient, a-few-group macroscopic cross-sections averaged regionwise, and options for saving the man power in making the input data are included in the code. The code LTKFK has also been prepared to make a library tape to be used with EXPANDA-2. (auth)

21640 (KAPL-M-6581) ASYMPTOTIC NUMERICAL SOLUTION OF THE REACTOR KINETICS EQUATIONS. MacMillan, D. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 2, 1966. Contract W-31-109-eng-52. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A family of asymptotic methods is given by means of which approximate numerical solutions may be obtained for the reactor kinetics equations, or for any system of equations including the reactor kinetics equations. The methods are accurate and efficient, and may be used with standard differential-equation-solver subroutines. Asymptotic methods may be similarly developed for other problems in which some of the variables are stable and have very short time constants. (auth)

21641 (KAPL-M-6596) LINEAR ANALYSIS OF XENON SPATIAL OSCILLATIONS. Stacey, Weston M. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 6, 1967. Contract W-31-109-eng-52. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A linear analysis of xenon-induced spatial power oscillations in reactor cores has been performed. Although this analysis proceeds along traditional lines (linearization, Laplace transformation, modal expansion), it is unique in that static few-group diffusion theory codes (e.g., KARE) may be used directly to evaluate the pertinent parameters, and in that the power distribution, as well as the power level, is incorporated into the formalism. Thus, the analysis is applicable to practical reactor models. A criterion is developed for predicting those combinations of power level and distribution, power coefficient, and separation of fundamental and first harmonic mode eigenvalues for which spatial power oscillations are just sustained (i.e., neither grow nor decay). Predictions based upon this criterion are found to agree with direct numerical solutions obtained with the SPRITE digital code. (auth)

21642 (ORNL-TM-908(Vol.2)) MSRE DESIGN AND OPERATIONS REPORT. PART VIII. OPERATING PROCEDURES. Guymon, R. H. (Oak Ridge National Lab., Tenn.). Jan. 1966. Contract W-7405-eng-26. 539p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The operating procedures comprise part eight of the twelve-part publication on MSRE. The information is presented in a twelve-part publication to avoid a portion of the duplication that would be required if separate and independent reports were prepared on each of the major aspects. Information is included on nuclear aspects of operation, auxiliary system operation, reactor startup, sampling, heat balance, instrument calibration, unusual operating conditions, reactor shutdown, and maintenance. (J.R.D.)

21643 (ORNL-TM-1747) HFIR TRANSIENTS AND REACTIVITY ACCOUNTABILITY. Cheverton, R. D.; Burke, O. W.; Cole, T. E. (Oak Ridge National Lab., Tenn.). Jan. 18, 1967. Contract W-7405-eng-26. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Transient behavior of the HFIR was investigated for the special case of positive reactivity additions, and an evaluation of static reactivity control requirements was made. Originally, these studies were made for the purpose of establishing appropriate design conditions; however, the information contained herein pertains essentially to the final design. Results from the transient calculations and comparisons with selected SPERT experiments indicate that the HFIR can withstand a 1.3% Δk insertion on a 0.030 sec ramp without significant core damage. This reactivity ramp represents the flux-trap-target optimum void insertion, which is considered to be the maximum credible reactivity accident. Based on these studies, it was concluded that the HFIR safety system is adequate for handling reasonable reactivity insertions, and that shutdown margins are sufficient. (auth)

21644 (ORNL-TM-1796) THE REACTIVITY BALANCE IN THE MSRE. Engel, J. R.; Prince, B. E. (Oak Ridge National Lab., Tenn.). Mar. 10, 1967. Contract W-7405-eng-26. 56p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Reactivity balances have been calculated for the MSRE since the start of power operation. After an initial period of manual calculations while the computer was being set up, machine calculations were started which are now routinely performed every 5 minutes while the reactor is in operation. The calculations are carried out by an on-line (Bunker-Ramo Model 340) computer using current values of reactor parameters such as temperature, power, and control-rod positions. All the known factors that have significant reactivity effects are computed and a residual reactivity required to keep the reactor just critical is evaluated. Early results showed that the ^{135}Xe poisoning in the MSRE (~0.3% $\delta k/k$ at 7.2 MW) was lower than was expected and results during Xe transients were used to construct a model to describe the Xe behavior. Subsequent results have been used to monitor the reactor operation for the appearance of anomalous reactivity effects. After the equivalent of 95 days operation at maximum power, the residual reactivity is $+0.05 \pm 0.04\%$ $\delta k/k$. This indicates excellent agreement between the predicted and observed behavior of the reactor. No significant anomalous effects have been observed. Prior to the start of reactor operation, a limit of $\pm 0.5\%$ $\delta k/k$ was imposed on the residual reactivity as a criterion for critical operation of the reactor. This limit has not been approached. (auth)

21645 (RCN-64) BIAS DUE TO FINITE MEASURING TIME IN NUCLEAR REACTOR NOISE ANALYSIS. Dragt, J. B. (Reactor Centrum Nederland, Petten). Feb. 1967. 19p. Dep. mn.

The effect of finite measuring time on the analysis of nuclear reactor noise, measured by means of a neutron counter, was investigated. It was found that this finite time introduces a systematic bias in the Feynman, auto-correlation and power spectrum analysis, not in the Bennett analysis. Expressions for the effect are given, which can be used for correcting experimental results. The effect appears to be closely coupled to the delayed neutron effect. It is shown that this finite time effect removes the divergence that occurs in the usual formulations for Feynman and auto-correlation analysis for a critical reactor. (auth)

21646 (RISO-129) DYNAMIC ASPECTS OF BOILING-HEAVY-WATER NUCLEAR REACTORS. PART II. Kjaer-Pedersen, Niels (Danish Atomic Energy Commission, Risoe, Research Establishment). Aug. 1966. 105p. Dep. mn.

A description and a discussion of the digital-computer code BRENDA, prepared for the Danish digital computer GIER, is presented. The code represents an attempt to simulate major physical effects which determine the dynamic behavior of a boiling-heavy-water reactor cooling channel. (auth)

21647 (SGAE-RE-5/1966) BRENNSTOFF-VERBRAUCH-SKENNZIFFERN FUER REAKTOREN UND REAKTORSYSTEME. (Fuel Consumption Coefficients for Reactors and Reactor Systems). Gruemm, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf, Institut fuer Reaktorentwicklung). 1966. 14p. (In German). Dep. mn.

Equations for the nuclear fuel needs of a reactor and a reactor system are derived. The consumption coefficients for an expanding population of one type reactor are derived and numerically evaluated for several reactor types. (J.S.R.)

21648 (TID-23767) 237 MW KRB NUCLEAR POWER PLANT. Quarterly Report No. 13, April 1–June 30, 1966. (Kernkraftwerk RWE-Bayerwerk G.m.b.H., Gundremmingen (West Germany)). 61p. (In English and German). (KRB-1966/2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The final finishing work was carried out on the reactor building so that the zero-power tests can be carried out. All the concreting and painting work in the building was completed. The precommissioning trials are complete but the ventilation system in the turbine house and the air gap air exhaust system will have to be tested again. During the period covered by the report the Technical Inspection Authority completed its assessment, which contains a total of 323 conditions which must be satisfied by the operator and the suppliers. The necessary conditions have been met and the water supply permit is valid. All the fuel elements, including the spares, were tested and are now in the storage pool ready for loading into the reactor. One element was damaged in the course of transportation to the storage pool. (J.R.D.)

21649 (TID-23769) SENA [REACTOR PROJECT] QUARTERLY REPORT NO. 17, JULY 1–SEPTEMBER 30, 1966. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). Nov. 29, 1966. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Delivery of spare first-core fuel assemblies to the site is reported. A summary of on-site construction work is included. Assembly of handling equipment and caves is reported along with progress on auxiliaries such as the turbine house, pumps, superheaters, and wiring. Testing of pressurizers and caves for leak-tightness is also reported. A work schedule is included along with photographs of equipment and machinery. (J.R.D.)

21650 (TID-23770) GARIGLIANO NUCLEAR POWER PLANT. Operation Report for the 4th Quarter of 1966. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Dec. 31, 1966. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Information is included on plant operation, core performance, plant chemistry, and health physics. (J.R.D.)

21651 (WAPD-MRP-119) PRESSURIZED WATER REACTOR PROJECT. Technical Progress Report for the Period October 22, 1966-January 20, 1967. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT(11-1)-Gen-14. 109p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

21652 (WAPD-TM-589) FRACTIONAL FACTORIAL EXPERIMENT IN FABRICATING THORIA FUEL PELLETS. Frankhouser, W. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1967. Contract AT(11-1)-Gen-14. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A mathematical approach to experiment design was employed to evaluate the effects of processing variables in the fabrication of ThO_2 fuel pellets as part of the LSBR (Large Seed Blanket Reactor) core development program at Bettis. The Resolution V fractional factorial design was chosen. Initially, 6 variables and 15 second-order interactions were investigated. The surface area of the original powder had by far the greatest influence on sintered pellet density, amount of surface porosity, and volume shrinkage. When surface area was held constant, other variables had statistically significant effects on the same properties which were not detected when the surface area was varied. This type of experiment was an effective tool in process development for ceramic fuels. (auth)

21653 (WAPD-TM-621) ANNULAR SEED-BLANKET REACTOR CRITICAL EXPERIMENTS. Smith, G. G.; Beck, J. W.; Glickstein, S. S.; (and others) (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1967. Contract AT(11-1)-Gen-14. 59p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A series of one-, two-, and three-module cores containing highly enriched UO_2 seeds and ThO_2 blankets have been studied. The purpose of this program was to compare design calculations with various measured core parameters. These parameters included the critical eigenvalues, seed power distributions, fast and thermal activation traverses, epithermal to thermal Th capture ratios, epithermal to thermal ^{235}U fission ratios, thermal disadvantage factors, and fast advantage factors. In addition, some information on core intermodule coupling was obtained. Each module of the assemblies consisted of a narrow hexagonal annular ^{235}U seed and an inner and outer ThO_2 blanket. The cores were designed to be nearly clean critical with no significant internal structure except fuel rod cladding in the active portion of the core. This allowed a fair test of the design model on highly absorbing narrow seed regions in a ThO_2 blanket. The design model was found to agree quite well with experimental results. The critical eigenvalues for all cores were consistent and close to unity. Near the seed-blanket interface, discrepancies between calculated and experimental traverses were noted and have been explained by spectrum-weighted cross sections and a higher order approximation to transport calculations. Monte Carlo calculations gave good agreement with experiment for thermal disadvantage factors and fast advantage factors. Fast leakage effects were found to be important in the calculation of the fast advantage factor in the seed region. (auth)

21654 (WCAP-3680-2) CONTROL OF XENON INSTABILITIES IN LARGE PWR'S. Quarterly Progress Report for the Period Ending December 31, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Jan. 1967. Contract AT(30-1)-3680. 44p. (EURAEC-1781). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

An evaluation of the sensitivity of space-time flux response to mesh spacing in the x-y plane has demonstrated that the presently employed mesh spacing of about 10 cm is adequate for instability studies in large cores. Stability characteristics in the x-y plane were evaluated for different size cores with equivalent (flat) power distributions. Where the magnitude of the oscillations is greater for the same perturbing influence non-linear effects were quite pronounced. The effect of the unperturbed steady-state power distribution on core stability was also investigated. Results indicate the spatial stability characteristics of the core are very sensitive to the initial, unperturbed power distribution. Initial studies were completed on the effect of perturbation location on the behavior of Xe-induced power oscillations. These studies suggest that the magnitude of the oscillations is dependent on perturbation location whereas the spatial characteristics are not, as long as the perturbing influence is withdrawn from the core shortly after causing the perturbation. (auth)

21655 BN-350 AND BOR FAST REACTORS. Leipunskii, A. I.; Afrikantov, I. I.; Stekolnikov, V. V.; (and others). At. Energ. (USSR), 21: 450-62(Dec. 1966). (In Russian).

The 150 MW(e) BN-350 reactor is designed to produce 120,000 tons of fresh water per day, and serve as a nuclear power station, also. Without any modifications of the core, the reactor will be able to operate with either ^{235}U or Pu fuel. A special fuel change device will be incorporated in the system. The control system was tested with circulating sodium at 500°C for 8000 hours. The emergency shutdown system received special attention; steps were taken to remove the afterheat efficiently, using an intermediate heat exchanger and loops. Results of the dynamic liquid flow tests are given. The gas space in the elements was increased to improve fuel element burnout characteristics without changing the overall dimensions of the fuel assembly. The BOR fast reactor will be used to study the characteristics of high-temperature, high-pressure fast reactors scheduled to exceed levels of 1000 MW. It will use 90% enriched $^{235}UO_2$ fuel. The reactor will contain special loops and beamholes for studying fuel elements. Its shielding, control, loading and unloading, and heat transfer systems are reviewed in detail. (TTT)

21656 EFFECTIVE MULTIGROUP METHOD FOR REACTOR CALCULATION. Khromov, V. V.; Kuz'min, A. M. At. Energ. (USSR), 21: 406-8(Nov. 1966). (In Russian).

A multigroup method that does not depend on the accuracy of the postulated distributions is proposed and verified by an example. (J.S.R.)

21657 DOPPLER TEMPERATURE COEFFICIENT EVALUATION FOR HOMOGENEOUS REACTORS. Mitenkov, F. M.; Averbakh, B. A.; Gorbunov, L. M.; Samoilov, O. B. At. Energ. (USSR), 21: 408-10(Nov. 1966). (In Russian).

Equations for the Doppler temperature coefficient of reactor reactivity were derived for homogeneous reactors. Numerical evaluations were graphed. (J.S.R.)

21658 EFFICIENCY OF CONTROL-ROD SYSTEM ARRANGED IN CORE AND REFLECTOR OF REACTOR SIMULTANEOUSLY. Nosov, V. I. At. Energ. (USSR), 21: 410-12(Nov. 1966). (In Russian).

Equations for the neutron distribution in the core and reflector were derived for the case of control rods arranged randomly in the core and reflector. The equations were evaluated for one control rod and for a control rod system. The results are shown graphically. (J.S.R.)

21659 LOSS OF COOLANT FROM A SIMULATED REACTOR LOOP. Redfield, J. A.; Margolis, S. G.; Murphy, J. H.; Snyder, G. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Appl., 3: 206-12(Apr. 1967).

Experimental data on the loss of coolant from a pressurized-water test loop are presented. The test loop simulated the components of a full-sized reactor plant with an electrically heated test section, a pressurizer, a heat exchanger, and a circulating coolant pump. Leaks in the coolant system were simulated by rupture disks at various locations. The test results are compared with predictions using the FLASH computer program. The calculated system-pressure transients showed good agreement with the tests. The pressure differential across the test section exhibited an oscillatory behavior, as did the predictions in one of the three tests. Measured test-section temperatures showed a considerable variation from predictions; however, these temperature predictions represent an improvement over those using previous calculation methods. (auth)

21660 THE EFFECT OF PLUTONIUM ISOTOPIC COMPOSITION ON THE DOPPLER COEFFICIENT IN FAST REACTORS. Shaviv, G.; Yiftah, S. (Soreq Nuclear Research Center, Yavne, Israel). Nucl. Appl., 3: 213-16(Apr. 1967).

The effect of Pu isotopic composition on the Doppler coefficient is examined in fast reactors having different chemical compositions of the fuel and different core volumes. It is found that for a given core volume and chemical composition the absolute value of the Doppler coefficient increases with increase of the amount of high Pu isotopes (^{240}Pu, ^{241}Pu, and ^{242}Pu). (auth)

21661 DIFFUSION PHENOMENA IN SLABS OF FINITE THICKNESS. Lewis, W. B. (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Appl., 3: 222-5(Apr. 1967).

A mathematical model of coatings of finite thickness is developed. Diffusion into a virgin region occurs for a specified time; diffusion out from the nonuniformly contaminated region then takes place for another specified time. The amount of contamination is given as a function of time and position, and the integrated contamination is given as a function of time. Curves are presented to make the model useful for the experimental determination of the diffusion coefficient. (auth)

21662 USE OF THE RITZ AND TREFTZ VARIATIONAL METHODS FOR THE CALCULATION OF THE THERMAL CONDUCTIVITY IN A DAMAGED REACTOR FUEL ELEMENT. Turilina, E. S.; Voskresenskii, K. D. (Power Engineering Inst., Moscow). Teplofiz. Vysok. Temp., 4: 660-9(Sept.-Oct. 1966). (In Russian).

Analytic and numerical calculations were made of the steady-state two-dimensional temperature field in a rod-type fuel element consisting of a fuel core, cladding, and a contact layer between the fuel and the cladding. The damage consists of replacement of part of the contact material by gas. The gas causes overheating of the element because of its poor heat transfer. The problem reduces to a boundary-value problem of the third kind. Two approximate solutions are obtained for the temperature. The first, by the Ritz method, includes a term showing the excess of the dimensionless temperature differential over the exact value. The second, which contains a term allowing for the deficit of the solution relative to the true value, is obtained by the Treftz method. The two approximate methods, which are independent of each other lead to practically identical results, thus showing that the degree of approximation used in the calculations is sufficient. A numerical example shows that when 25% of the contact metal between the fuel and the cladding is replaced by the gas, the temperature can rise from ~700 to 930°C. When the gas fraction is increased to 75%, the maximum temperature can reach 1550°C. Possible applications of the method for other fuel elements are discussed, and it is pointed out that the dimensionless results of the calculations are valid for all fuel element groups that are related by conditions of geometrical and thermal similarity. (ATD)

21663 NUCLEAR ENERGY, A FACTOR MAKING FOR GREATER DEPENDABILITY OF ENERGY SUPPLIES. Leclercq, Jean; Van Meerbeeck, Michel. Euratom Bull., 6: No. 1, 10-16 (Mar. 1967).

The importance of developing nuclear energy in western Europe is discussed in terms of costs, raw fuel reserves, and dependability. Quantitative comparisons of present and future energy requirements and conventional fuel consumption are given. These comparisons show the increasing dependency of the common market area on external sources of conventional fuels. Nuclear energy is the most promising energy source for meeting future power requirements. (L.C.L.)

21664 LONG LIFE FOR CONVERTERS. Caprioglio, Pietro; De Bacci, Mario. Euratom Bull., 6: No. 1, 2-5(Mar. 1967).

A discussion of the economics of operation of reactors for power production is presented. A projected requirement schedule for fissile material during the next 50 years is given. (M.L.S.)

21665 CERAMIC NEUTRON ABSORBER FOR CONTROL AGENTS. Haessner, F. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Nucl. Mater., 21: 121-48(Feb. 1967). (In German).

A bibliographic review is presented of the most significant studies appearing in the last five years on ceramic neutron absorbers for reactor control rods. In problems connected with the preparation only such aspects are described which are of technical significance and the typical characteristics of the particular construction group are considered. Nuclear physical questions and preparation methods for complete control elements are not considered. The general view point of the construction material selection is outlined. B containing compounds, compounds of the rare earths, and compounds of B with the rare earths are considered. 204 references. (J.S.R.)

21666 EFFECT OF THE CHEMICAL REACTION BETWEEN STEAM AND CLADDING ON THE ANALYSIS OF A POWER REACTOR ACCIDENT. Ivins, R. O. Argonne Nat. Lab. Rev., 3: 93-101(Oct. 1966).

The effect of chemical reactions of cladding and steam in both reactor excursions and loss-of-coolant accidents are considered in some detail. The conversion of steam into hydrogen, which can then be liberated to re-combine with oxygen in an explosive reaction, is examined. The analysis is directed toward the consequences of a loss-of-coolant accident, since, in most power reactors, this is considered to be the maximum credible accident. (M.L.S.)

21667 CONSERVATION ECONOMICS AND REACTOR TECHNOLOGY. Neef, W. I.; Jones, E. D. Jr. (Pacific Northwest Lab., Richland, Wash.). Nucl. Appl., 3: 32-42(Jan. 1967).

The computer code VESTA has been written to calculate the interactions of the characteristics of light water, advanced converter, and breeder reactors with respect to consumption of U, production of Pu, and national electric power capacity, to about year 2020. Economic factors such as Pu price, fuel fabrication cost, fuel-cycle minimization decisions, and Pu-inventory time lags will be as important as technological factors such as thermal reactor type, breeder development rate, Pu recycle techniques, and thermal-reactor specific power. For a wide range of conditions and levels of development effort, the introduction of low-gain breeders by 1975 and of high-grain breeders by 1990 will result in cumulative U usage by 2020 below the level at which very high-priced U ore will be required. (auth)

21668 THE AMOUNT OF NUCLEAR FUELS REQUIRED FOR THE NUCLEAR POWER GENERATION PROGRAM. Nagashima, Kikusaburo; Izumi, Tamotsu (Sumitomo Atomic Energy Industry, Ltd., Japan). Genshiryoku Kogyo, 12: No. 10, 9-16 (Oct. 1966). (In Japanese).

In the nuclear power generation program in Japan, the calculation of the amount of nuclear fuels required for the program is an important point in the nuclear fuel policy. Various formulas for fuel requirements are presented, taking into account reactor characteristics which are used as the basis in the calculation of the amount required for the program. In the case where depleted uranium is reused by recycling, the amount for the program, taking the recycle period into consideration, is obtained, with the formula for the effect of this recycling period. For recycling by blending the limitations due to ^{236}U are considered. The total amount as U_3O_8, required for the period from 1975 to 1990, with half for BWR's and the other for PWR's, has been calculated. When fresh fuel alone is used, it is approx. 175,000 tons (in U_3O_8); by recycling the depleted uranium, however, the amount is reduced by approx. 15,000 tons. (NSA of Japan)

21669 NUCLEAR POWER: TWO YEARS AFTER GENEVA. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). J. Brit. Nucl. Energy Soc., 6: 10-23(Jan. 1967).

A review is made of the world energy needs and resources, the current status of reactor technology, and the future development of more advanced nuclear power reactors. Growth of world population and energy consumption are estimated to the year 2000, and a review is made of national nuclear power programmes. Costs are compared for the current light water, AGR, and Candu type plants, and also for projected near breeder and breeder reactor plants. Uranium resources and requirements are reviewed. (INIS-UK)

21670 FUEL CYCLES FOR CROSSED-PROGENY FUELS IN CONVENTIONAL AND NOVEL CONFIGURATIONS. Deonigi, D. E. (Pacific Northwest Lab., Richland, Wash.). Nucl. Appl., 3: 18-25(Jan. 1967). (BNWL-SA-275).

Crossed-progeny fueling systems are those in which a reactor, such as a PWR, would burn ^{233}U in natural U and supply Pu to a D_2O reactor, which in turn would burn the Pu in Th and supply ^{233}U for the PWR. Optimum moderator-to-fuel ratios are determined for these systems. They are influenced noticeably by Pu credits but little by processing costs. Conversion ratios, neutron balances, and fuel cycle costs are calculated. Uranium-233 in natural U is an attractive fuel in a PWR, but Pu-in-Th, which does not appear attractive in a PWR, does appear so in a D_2O-moderated reactor. (NSA of Japan)

21671 FEATURES AND RESULTS OF SEVERAL PROGRAMS OF RADIATION-DAMAGE SURVEILLANCE OF POWER REACTOR PRESSURE VESSELS. Serpan, Charles Z. Jr.; Steele, L. E.; Hawthorne, J. R. (Naval Research Lab., Washington, D. C.). J. Basic Eng., 89: 221-32(Mar. 1967).

The meaning, purpose, and value of reactor-pressure vessel surveillance are discussed. Features of the surveillance programs in the Yankee, Big Rock Point, SM-1, and SM-1A reactors are briefly described with results of testing metallurgical specimens from these programs. The surveillance program to be effected in the Army MH-1A reactor is also described. Certain problems which occurred in the course of these programs are discussed as well as the proposed ASTM recommendations for radiation-damage surveillance programs. (auth)

21672 OUTLINE OF NUCLEAR POWER TEST LOOP FOR TOKYO UNIVERSITY. Ishikawajima-Harima Giho, 6: 418-23 (Sept. 1966). (In Japanese).

This equipment is intended for studies in heat transfer under various conditions, and consists of three loops: (1) Boilding Water Heat Transfer Test Loop (Main Loop). (2) Boiling Water Heat Transfer Test (Sub-Loop). (3) Gas Heat Transfer Test Loop (Gas Loop). (1) is designed as a model of the primary coolant circuit of a water cooled reactor, and is used for investigating boiling water heat transfer under the conditions of 30 atm abs pressure, saturation temperature at that pressure, maximum heat flux above 1×10^6 kcal/m^{2}h, and maximum coolant flow rate of 200 l/min. Light water is used as primary coolant in this loop. (2) is to be used for studying transient heat transfer in various liquids and heat transfer of organic liquids at atmospheric pressure, saturation temperature, and with maximum flow rate of 60 l/min. The primary coolants in this loop are light water and organic liquids. (3) is for experiments in heat transfer of various gases. (auth)

21673 CATAPULT FOR GERMAN NUCLEAR POWER PLANTS? Mueller, Wolfgang D. Atomwirtschaft, 12: 17-21 (Jan. 1967). (In German).

The installation of commercially competitive nuclear power plants in Germany is compared with that installed in other countries to show the lag in the German construction. The reasons for this lag and the possible damage to German industrial growth are discussed. The steps planned to remedy the lag are outlined. The contribution that the states must make are indicated. (J.S.R.)

21674 PRINCIPLES OF LEAD SHIELDING DESIGN. Smith, R. (Lead Development Association, London). Nucl. Eng. Design, 4: 459-79(Dec. 1966).

The correct choice of the composition and form of Pb to give the required physical properties is the first essential in the production of an efficient shield. The application of the correct principles by the designer will then ensure that the manufacturer is able to employ the most suitable techniques in the production of the shield, whether it is a massive thick shield for a container, or thin sheet Pb to be applied to the walls to form a room shield. Where local shielding of a more temporary nature is required it is essential to know the different systems of Pb bricks which are available, as it is with the special products such as lead plastic composites which have been produced for specific requirements. (auth)

21675 DISCUSSION ON: "CONSIDERATIONS ON FISSION PRODUCT RELEASE SUPPRESSION FACTORS FOR ENGINEERED SAFEGUARDS FOR NUCLEAR POWER PLANTS" BY T. TAGAMI. Farmer, F. R. (United Kingdom Atomic Energy Authority, Warrington, Eng.). Nucl. Eng. Design, 4: 490(Dec. 1966).

It is noted that the confidence in the precision of assessing the consequence of reactor accidents often becomes established in proportion to the degree of assessment method sophistication. It is argued that through engineering safeguards a reduction in ^{131}I release in reactor accidents may be achieved by four to six orders of magnitude. If this is to afford protection to the public, a corresponding high degree of plant reliability is required. It is concluded that, to achieve protection by engineered safeguards, the minimum performance of these safeguards must be absolutely established. (J.R.D.)

21676 GETTING MORE OUT OF BWR'S. Roy, George M. (General Electric Co., San Jose, Calif.). Nucleonics, 24: No. 11, 41-3; 53(Nov. 1966).

Design improvements in the General Electric Company's boiling water reactor power plants are discussed. The new design bases are concerned primarily with performance sizing and increased core power density to permit larger generating units and higher output per component. (H.D.R.)

21677 SITE ASSEMBLY: A NEW APPROACH FOR U. S. REACTOR VESSELS. Cramer, T. L. Nucleonics, 24: No. 11, 58-61(Nov. 1966).

The feasibility of a large steel reactor pressure vessel assembly on-site is explored. Field assembly is seen to have great advantages over shop assembly for reactor sites that would require overland shipment of the large vessels. Procedures suggested by the Chicago Bridge and Iron Company to site-assemble a reactor vessel with dimensions of 20 ft 11 in. ID, 70 ft high, and 6⅜ in. thick are presented. (H.D.R.)

21678 RADIATION MEASUREMENTS IN THERMAL REACTORS. Kinchin, G. H. (Atomic Energy Establishment, Winfrith, Eng.). pp 3-7 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

Radiation measurements are necessary at all stages from development to operation of thermal reactors. The important role of radiation measurements in nuclear data experiments is mentioned. The use of radiation measurements in reactor physics experiments and in reactor operations is emphasized. Basic reactor physics experiments intended to check nuclear data illustrate a number of widely used methods of measurement: time-of-flight methods for determining neutron energy spectra, the reactor oscillator technique for measuring effective reactor cross sections, and foil techniques for determining slowing down and diffusion lengths. The application of these and other techniques to experiments with uniform lattices, to nonuniform lattices and finally to operating power reactors is reviewed. (auth)

21679 RADIATION MEASUREMENTS IN FAST REACTORS. Smith, R. D. (Atomic Energy Establishment, Winfrith, Eng.). pp 8-11 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The extent to which measurements in fast reactors are likely to be needed in the future is discussed. The types of measurements needed are divided into those required for design purposes, mostly carried out in zero power reactors, and those required mainly for operational purposes in power reactors. Spectrum measuring devices are of particular importance and those used in zero power reactors are discussed. It is pointed out that there is a need for a spectrometer that could be used in a power reactor. (auth)

21680 RADIATION MEASUREMENTS IN REACTOR SHIELD DESIGN. Butler, J. (Atomic Energy Establishment, Winfrith, Eng.). pp 12-17 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

In recent years considerable progress has been made with the development of computer codes which solve the transport equation in a reactor shield from the fundamental nuclear data, and it is no longer necessary to rely exclusively on mock-up experiments, which have traditionally formed the basis of all reactor shield design calculations. The changing role of radiation measurements in the development of shielding techniques is reviewed and the future requirements are considered under three headings: spectrum measurements in simple geometries, measurements in reactor shield test facilities, and integral measurements made during the commissioning and operation of power reactors. (auth)

21681 THE APPLICATION OF THE PULSED NEUTRON TECHNIQUE TO GAS-COOLED POWER REACTORS. Abbott, D. G. (Berkeley Nuclear Labs., Eng.). pp 21-31 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The pulsed neutron technique, i.e., the study of the prompt thermal neutron flux decay rate following the injection of a pulse of fast neutrons, was used to measure subcritical reactivities on full-size gas-cooled power reactors during their commissioning programmes. The experiments show that the technique is not spatially dependent even for these large-core configurations, and the results obtained, in the majority of cases, are in good agreement with theoretically derived values. Special equipment was designed and used to measure the temperature coefficient of the reactor control rods between 15 and 210° C, and the results obtained show that this parameter is strongly dependent on the reactivity worth of the control rods which are used. (auth)

21682 MEASUREMENT OF FUEL RATING BY GAMMA SCAN AND WIRE ACTIVATION METHODS: A DISCUSSION BASED ON WINDSCALE ADVANCED GAS-COOLED REACTOR EXPERIENCE. Brightman, F. G.; Norbury, J. F. (United Kingdom Atomic Energy Authority, Windscale, Eng.). pp 37-47 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

Two methods are described for the determination of rating distribution, which with appropriate calibration give absolute rating estimates. The methods are non-destructive gamma scanning for fission products and wire activation. Rating, expressed as fission rate per unit mass of fuel, is directly related to the gamma activity of a suitable short-lived fission product. The choice of fission product for observation by gamma scanning is discussed, and the use of the $^{140}Ba/La$ pair is described. An account is given of errors arising in the Windscale advanced gas-cooled reactor measurements, and it is shown that relative rating measurements may be made at a point with an error of about 3½% (1σ). Absolute point values are obtainable to ±6½%; efforts are being made to improve this. An outline is given of present developments of the technique to measure rating distribution on complete stringers of fuel, by observations of very short-lived products such as ^{142}La. The indirect determination of rating distribution of activation of stainless steel wires in Windscale advanced gas-cooled reactor channels is described, and the measurement of ^{56}Mn and ^{56}Cr reaction rates is discussed. The errors are listed, and some comment is made on their variation with quantity measured. Absolute values of point rating are currently measured by this method to ±7% (1σ). Possible developments are mentioned, leading to improved accuracy on both relative and absolute scales. (auth)

21683 THE MEASUREMENT OF FLUX DISTRIBUTION IN THE WINDSCALE ADVANCED GAS-COOLED REACTOR AT ZERO POWER AND COMPARISON WITH CALCULATION. Cartwright, D. K. (United Kingdom Atomic Energy Authority, Risley, Eng.); McKnight, J. A.; Pickering, W. pp 48-53 of Proceedings of the International Conference on Radiation Measure-

ments in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

During the commissioning of the advanced gas-cooled reactor detailed radial and axial flux plots were made using 75% manganese–nickel wires 0.020 in. in diameter. These measurements are described and compared with those calculated using ARGOSY. The wires were fitted into the tie tubes of the fuel element and extended from the top reflector to the tundish below the reactor. Hypodermic tubes were used to enable this to be done. After removal of the wires, preselected 1 in. lengths of wire were chopped from the long lengths and the γ activity measured using NaI scintillation counters. For the calculation lattice cell constants were obtained from the ARGOSY 4 computer program in three annular zones, following the methods recommended by Tyror. The three zones were identified by the three sizes of re-entrant coolant passages designed to hold the moderator temperature fairly constant across the core. The re-entrant passage cross sections vary axially in the core and have been represented by axially averaged values in these two-dimensional calculations. The reaction rate measurements described provide the best evidence available for comparison of reactor codes and although restricted to the cold unirradiated condition the core contains so many different types of perturbations that it imposes a very severe test. From analysis of the experimental results, the standard error of a normalized flux plot was predicted as about 1.5%. From the comparison of the measurements in one horizontal plane of 95 points with calculation it is concluded that ARGOSY can be used to obtain lattice data which enable the prediction of channel flux variation within a standard deviation of 2% in a cold unirradiated nonuniform core. This accuracy can be obtained using TRIFID, a one mesh point per channel code, when absorbers are smeared using the Clark method and vacancies by the Buckler method. (auth)

21684 MEASUREMENTS OF NEUTRON FLUX AND FISSION RATE IN ADVANCED GAS-COOLED REACTOR LATTICES. Collinson, B.; Higham, E. J.; Rowbotham, J. R. (United Kingdom Atomic Energy Authority, Windscale, Eng.). pp 54-62 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

For the power generation evaluation of a heterogeneous advanced gas-cooled reactor, a knowledge of the gross distributions of thermal flux and fission rate over the core, and their fine structure within lattice cells, is required. To test methods of calculation a series of measurements of these distributions were made at Windscale for a range of fuels and lattices. Techniques developed for use in both intermediate 10^7-10^8 neutrons/cm^2/sec and low 10^4-10^5 neutrons/cm^2/sec irradiation flux environments are discussed. The measurement requirements are discussed together with the choice of manganese detectors for flux and fuel material for fission rate measurements. The methods of measurement and the irradiation and counting details involved in the HERO zero energy reactor and FIFI subcritical stack investigations are described. Typical errors involved in the measurements are indicated, viz., ±1% on gross flux ratios, ±½% to ±1% on fine and hyperfine flux ratios, and ±1% to ±1½% on fine fission rate ratios. These satisfied in general the accuracy requirements for power design evaluation and testing of theoretical methods. (auth)

21685 MEASUREMENT OF NEUTRON FLUX DISTRIBUTION NEAR THE ENDS OF URANIUM METAL RODS. Walsh, M. (Berkeley Nuclear Labs., Eng.). pp 95-105 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

In a gas-cooled reactor the axial flux distribution shows a series of equally spaced peaks arising from the gaps between fuel elements. In order to measure this in detail a series of experiments using uranium metal rods within air channels in a graphite moderator was carried out in cave C of the source reactor NESTOR at the Atomic Energy Establishment, Winfrith, England. Owing to the difficulty of using small systems for making measurements of large perturbations, considerable effort was devoted to initial measurements of the overall flux using small BF_3 counters and fission chambers. Later, detailed measurements in the fuel were made by the use of manganese and fissile foils. The survey covered variations in the values of channel diameter, rod length, axial gap length and enrichment. The effect of placing various absorbing materials in the axial gap was also investigated. The largest measured value of the ratio of the peak to minimum microscopic flux was just over 1.3 in the air channel and just over 1.8 in the uranium. The results show that before the macroscopic distribution can be removed from the overall flux distribution allowances of up to 10% in the value of the overall distribution have to be made, owing to the interaction between the macroscopic and all microscopic flux. A summary of the most recent series of measurements is included with an outline of the intended treatment. A discussion on the ability of various computer programs to represent the system is also presented. (auth)

21686 NEUTRON ENERGY SPECTRA ABOVE AN ADVANCED GAS-COOLED REACTOR CORE. Gore, J. E.; Mountain, W. (Berkeley Nuclear Labs., Eng.). pp 162-7 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

Neutron energy spectra in the eV and MeV energy ranges were measured above the centre of a typical advanced gas-cooled reactor fuel channel and above an interstitial point in the moderator using resonance sandwich foils and nuclear emulsion detectors. The resulting spectral distributions agree well both in magnitude and shape with theoretical predictions which take into account axial streaming along the fuel channel. The measurements show the feasibility of using sandwiches of different resonance detectors within the same thermal neutron shield, but they have emphasized the difficulty of extracting information from simple sandwiches when the angular distribution of the neutron flux is unknown. (auth)

21687 FAST-NEUTRON SPECTRAL MEASUREMENTS IN THE ENRICO FERMI ATOMIC POWER PLANT. Page, E. M. (Atomic Power Development Associates, Inc., Detroit). pp 179-92 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

A programme designed to provide additional information concerning the neutron spectrum in the core and blanket of the Enrico Fermi atomic power plant is described. Some of the difficulties in implementing such a programme due to the design, operating philosophy and environment of a sodium-cooled fast power reactor are discussed. Comparison of measured threshold-type reaction rate distributions with calculations indicate that standard multi-group techniques for the calculation of high energy fluxes at distances of the order of 75 cm from the core boundary can be used with confidence. The data, together with those of the low energy activation detectors $^{55}Mn(n,\gamma)$ and $^{197}Au(n,\gamma)$, support earlier ^{235}U scans in showing that low energy reaction rates rise severely near the edge of the blanket. These rises are being confirmed by temperature measurements. Absolute reaction rates obtained with fission counters support the general contention for fast reactors that the lower energy flux is greater than calculated. A reverse trend is indicated for the higher energy fluxes, but accurate spectrum measurements were hampered by uncertainties in counter loadings and difficulties in power normalization. (auth)

21688 STUDY AND RESEARCH ON HIGH TEMPERATURE GAS-COOLED REACTORS. Cumo, Maurizio. Riv. Ing., No. 3, 207-20(Mar. 1966). (In Italian).

The general characteristics of the experimental prototypes of high temperature gas-cooled reactors are given. The individual characteristics of the Dragon, HTGR, and AVR reactors are then outlined. The characteristic problems in the construction of these reactors–fuel fabrication, purification of coolant, corrosion and mass transfer in the moderator, graphite behavior, radioinduced damage, graphite permeability, thermal stresses on graphite, thermal exchange and fluid dynamics, and characteristics of the neutron flux—are considered individually. (J.S.R.)

21689 BURNUP PHYSICS OF HETEROGENEOUS REACTOR LATTICES. Poncelet, Claude Ghislain. Raleigh, N. C., North Carolina State of the Univ. of North Carolina, 1965. 181p. Thesis.

A method is given for the calculation of fuel burnup in a heterogeneous reactor lattice cell by use of THERMOS and MUFT codes in the epithermal and fast ranges. The method accounts for all non-linearities and mutual connections in the transport equation for the flux and the isotopic depletion equations. The spatial distribution of epithermal reaction rates is calculated by the Monte Carlo technique. The composite code, called LASER, will calculate: (1) spatial distribution of neutron flux spectrum and fuel composition as a function of burnup (2) reaction rates and effective cross sections for the cell. (TSS)

21690 STEAM GENERATOR, PARTICULARLY FOR USE WITH NUCLEAR REACTORS. (to Gesellschaft fuer Kernforschung m.b.H.). British Patent 1,053,498. Jan. 4, 1967. Priority date Mar. 5, 1963, Germany.

A design is given for a steam generator to be used with steam-cooled reactors. The generator consists of a tank containing condensate. A main pipe camping superheated steam passes through the condensate, and has several branch pipes. Some of these go across the outlet for generated steam. The others go into the tank below the condensate surface. (M.L.S.)

21691 SHAFT SEALS. Maidment, Leslie (to United Kingdom Atomic Energy Authority). British Patent 1,053,385. Dec. 30, 1966. Filed June 14, 1963.

A design is given for a low speed shaft seal, that is particularly applicable to reactor control systems where the drive mechanism is located outside the reactor vessel. Detailed specifications for the seal and drive mechanism housing are illustrated by specific examples. (M.L.S.)

21692 FLUID CONTROL SYSTEM FOR BOILING NUCLEAR REACTOR. Schortmann, Walter E. (to Combustion Engineering Inc.). U. S. Patent 3,284,307. Nov. 8, 1966. Filed Oct. 30, 1963.

A pressure actuated control system is described that includes no moving parts and reacts solely in response to pressure variations in the reactor for a boiling reactor employing moderator-coolants as the vaporizable medium. The moderator fluid is moved from a reactivity sensitive region of the reactor through a driving force provided by an unwanted pressure rise in the system. This removal of the moderator decreases the reactivity of the core and effects a momentary shut down of the heat source to prevent a pressure surge. When vapor demand decreases and system pressure starts to rise, the pressure increase directly and instantaneously causes an action that prevents the continuation of the increase in pressure. As soon as the vapor bubbles collapse under the increased pressure and cause moderator to be added to the core region, the removal of an equivalent amount of moderator takes place in a natural manner leading to control of the reactor and prevention of high pressure surges. (B.L.M.)

21693 REATTORI A LIQUIDO ORGANICO, VII CONGRESSO NUCLEARE, 11–17 GIUGNO 1962. (Organic Cooled Reactors, 7th Nuclear Conference, 11–17 June 1962). Rome, Comitato Nazionale Energia Nucleare, 1964. 622p. (CONF–620603).

The 33 papers presented at the 7th nuclear conference on organic cooled reactors are compiled. The topics presented were reactor physics, reactor engineering, chemical technology and metallurgy, and applied research of organic reactors. Individual abstracts were prepared for the papers. (J.S.R.)

For abstracts of individual papers see: 21694–21724, 21786, and 21787.

21694 SCATTERING AND SCATTERING COOLING COEFFICIENT IN ORGANIC MODERATORS. Boffi, V. C.; Demanins, F.; Molinari, V. G. pp 43-57 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The methods used for the calculation of the scattering and scattering cooling coefficients for the Orgel reactor are outlined. The results obtained are compared with data from the literature on benzene, diphenyl, and terphenyl. The theoretical values obtained for the scattering coefficients are greater than the experimental values, but the theoretical values for scattering cooling are less than the experimental values. (J.S.R.)

21695 NEUTRON CALCULATION METHOD FOR THE ORGEL CORE. Casini, G. (EURATOM, Ispra, Italy). pp 29-41 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The method for the neutron calculation of the Orgel core is based on the results of the French correlation for the lattice cooled and moderated with heavy water. It is assumed in the calculation that the adjusted parameters (the thermal fission factor and the constants A and B of the effective resonance integral) remain constant in the case of Orgel type lattices. The differences in the neutron balances introduced by the organic liquid in place of the heavy water are considered. Also the method is extended to the case of UC lattices. The results obtained for buckling are compared with experimental results. (J.S.R.)

21696 DETERMINATION OF THE THERMAL NEUTRON SPECTRUM IN AN ORGEL CORE. Rossi, G. (EURATOM, Ispra, Italy). pp 21-8 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The thermal neutron spectrum in an Orgel core is calculated taking into consideration the rethermalization and the flux hardening. The limiting cases are graphed. (J.S.R.)

21697 PHYSICS OF THE ORGEL PROJECT. Kind, A. (EURATOM, Ispra, Italy). pp 15-20 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

A brief review is given of the methods to be used in the calculation of the principal physics parameters of the Orgel reactor, a heavy water-moderated, organic liquid-cooled reactor concept. (J.S.R.)

21698 MEASUREMENT OF THE DIFFUSION PARAMETERS OF ORGANIC MODERATORS WITH THE PULSED NEUTRON SOURCE TECHNIQUE. Demanins, F.; Rado, V.; Vinci, F. pp 59-67 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The scattering parameters of diphenyl, Dowtherm A, and benzene were measured using the pulsed neutron source technique. The results are tabulated. (J.S.R.)

21699 SCATTERING AND SPECTRUM OF THERMAL NEUTRONS IN ORGANIC MODERATORS. Boffi, V. C.; Molinari, V. G.; Parks, D. E. pp 69-90 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The construction of a theoretical model for the neutron diffusion length in benzene is outlined. The results of the calculation on the thermal terms and of some nuclear microscopic parameters in organic moderators, based on the theoretical model, are reported. Particular emphasis is given to diphenyl and the results are compared with the analogous results obtained on the basis of the gaseous model. (J.S.R.)

21700 EXPERIENCE WITH THE NUCLEAR CODES FOR THE PRO (ORGANIC REACTOR PROGRAM) PROJECT. Adamoli, F.; Brusa, L.; Console, M.; Faleschini, B.; Fornaciari, P. pp 91-118 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The nuclear codes used for the calculation of the nuclear constants and the flux distribution of the PRO reactor are outlined. The codes for the design of a reactor are analyzed. (J.S.R.)

21701 NEUTRON-THERMAL PROGRAM FOR ORGANIC-MODERATED REACTORS. Gentilini, L.; Tamagnini, C.; Tondinelli, L.; Valli, G. pp 119-35 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The programming of the nuclear codes LIFE, SOCO I, SOCO II, and COCA for the calculation of the reactor diameter, reactor characteristics, and kWd cost is outlined. The typical results obtained are graphed. (J.S.R.)

21702 SOME RECENT DEVELOPMENTS IN ORGANIC REACTOR TECHNOLOGY. Trilling, C. A. (Atomics International, Canoga Park, Calif.). pp 139-60 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964.

Data obtained in recent studies on the coolant (terphenyl) decomposition, fuel element development, and formation of fuel element surface deposits or fouling are reviewed. The significance of new data for the evaluation of the decomposition rate of the terphenyl under exposure to heat and radiation is considered. The development of fuel elements for organic cooled reactors was directed toward the use of either U-alloy metal or UO_2 fuel clad with extended surface Al of APM (SAP). Experiences from the initial operation of the third core of the OMRE on fuel element fouling are discussed. It is suggested that fouling of fuel element surfaces can be minimized or even eliminated by minimizing the introduction of impurities into the coolant, removing these impurities as fast as they are introduced to maintain their concentration in the coolant at a minimum, and eliminating any areas of low flow for coolant stagnation in the core. (J.S.R.)

21703 ORGANIC COOLED REACTOR PROGRAM IN THE UNITED STATES. Pahler, R. E.; Barber, R. W. (Atomic Energy Commission, Washington, D. C.). pp 161-72 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964.

The organic cooled reactor program in the United States includes a broad effort on research and development and on operation of experimental reactors, all of which would lead to the construction and operation of nuclear power reactors of this type. The studies include work in coolant technology, fuels and materials, heat transfer, and process development. An outline is given of some significant results obtained in these areas. (J.S.R.)

21704 PRESENT STATE OF THE ORGANIC REACTOR PROGRAM. Pedretti, A.; Di Menza, R. pp 173-83 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The organic reactor program includes the design, construction, and operation of a reactor moderated and cooled with organic liquid with 30 MW(t) power for the first core and increased to 60 MW(t) for successive cores. The progress made in the design of the primary surface, the auxiliary, and the secondary surface is outlined. The general characteristics of the reactor and its major components are briefly described. (J.S.R.)

21705 STUDY OF A 250 MW(e) ORGEL POWER PLANT. Charrault, J. C.; Lafontaine, F. (EURATOM, Ispra, Italy).

pp 185-218 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The results of a preliminary study of a 250 MW(e) Orgel power plant are outlined. The characteristics of the Orgel reactor are given and the classical steam installation is described. The nuclear installation is discussed. The economic aspects are given and discussed. An Orgel power station is compared with a classical power station. (J.S.R.)

21706 DESIGN PROBLEMS OF THE CORE OF THE PRO REACTOR. Baldetti, S.; Bavestrelli, L.; Pierazzi, L. pp 219-37 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The design of the core of the PRO reactor is given and design problems encountered are summarized. These include the temperature limit, optimization calculations, thermal calculations at the core, and structural problems. Solutions proposed or adopted are described for some of these problems. (J.S.R.)

21707 INSTRUMENTATION OF THE CORE OF THE PRO REACTOR. Cesari, F.; Gadola, A.; Garagnani, G.; Raimondi, T. pp 239-55 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The characteristics of the core instrumentation of the PRO reactor are described and the measurements made inside the reactor vessel are outlined. The system used for the mapping of the neutron flux is illustrated and described in detail. The instrumented fuel elements are also described. The thermocouple used for the measurement of the temperature of the organic liquid and the device used for the detection of damaged fuel elements are shown and discussed. The techniques used for data processing are outlined. (J.S.R.)

21708 TABULATION OF THE AUXILIARY PLANTS OF THE ORGANIC REACTOR. Cassinari, U.; Guidotti, M. pp 257-70 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The primary auxiliary chemical plant of the organic reactor is the installations for degassing and pressurizing, purification, removal of polymer decay products, processing of liquid waste, processing of gaseous waste, accumulation and storage of radioactive gases, and receiving and processing of chemicals. Each of these installations is described. (J.S.R.)

21709 DESIGN PROBLEMS OF THE HEAT EXCHANGE INSTALLATION IN THE ORGANIC REACTOR. Cannata, P. (Compagnia Tecnica Industrie Petroli, Rome). pp 271-92 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The characteristics and nuclear data on proposed and prototype organic cooled reactors are given and the designs of the primary circuits are discussed. The characteristics of the thermal exchange installations and the secondary circuits of the various designed and prototype reactors are compared. Cost data on this reactor concept are briefly discussed. (J.S.R.)

21710 UTILIZATION OF THE HEAT PRODUCED BY A REACTOR COOLED AND MODERATED WITH ORGANIC FLUID. Biondi, L.; Vacchelli, G. pp 293-308 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The utilization of the heat produced in an organic cooled and moderated reactor is calculated for five heat cycles with and without resuperheating. The results are tabulated. Intermediate resuperheating has significant advantages especially when high humidity is desired in the turbine. Higher temperature values yield higher pressure values. At all available temperatures there is a corresponding pressure which gives the maximum yield. (J.S.R.)

21711 SEMI-QUANTITATIVE DETERMINATION OF THE o,m,p ISOMERS OF TERPHENYL BY X-RAY DIFFRACTION IN MIXTURES OF DIPHENYL AND TERPHENYL. Toussaint, C. J. G.; Vos, G. (EURATOM, Ispra, Italy). pp 311-25 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

A simple and rapid x-ray diffraction method for the semiquantitative determination of the o,m,p isomers of terphenyl is given. It can be applied to reduced samples without destruction of these samples. The limit of detection of the o and m terphenyl is 0.5 and 1% for the p-terphenyl. In the absence of m-terphenyl the last limit can be reduced to 0.2%. (J.S.R.)

21712 DETERMINATION OF SOME METALLIC IMPURITIES IN ORGANIC HEAT CARRIERS. Collin, J.; Hainski, Z.; Rossi, G.; Vos, G. (EURATOM, Ispra, Italy). pp 327-51 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

Three methods, x-ray spectrography, emission spectrography, and spectrophotometry, for the determination of metallic impurities in organic heat exchangers are described. The x-ray method is used for the determination of Fe, Ni, and Co. It is a fast and nondestructive method with a sensitivity of the order of 0.5 ppM. The Cu spark spectrographic method is used for the determination of Fe, Cr, Ni, Mn, Al, Mg, and Ca. The spectrophotometric method is used for the determination of Cr, Fe, and Ni. The operational techniques for each method are outlined. (J.S.R.)

21713 ACTIVATION STUDIES FOR THE ORGEL REACTOR. Girardi, F.; Pauly, J. (CCR-EURATOM, Ispra, Italy). pp 353-62 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964.

The activation studies made at the nuclear chemistry service at Ispra are briefly summarized. These include activation analysis of impurities initially present in the terphenyls, activation analysis of corrosion products, determination of the corrosion products of the activated structural material in the reactor core, and monitoring of the fission products released by the fuel element. (J.S.R.)

21714 CURRENT IN-PILE IRRADIATIONS OF SANTOWAX OMP. Mason, E. A.; Bley, W. N.; Morgan, D. T. (Massachusetts Inst. of Tech., Cambridge). pp 363-83 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964.

The in-pile loop equipment used in the irradiation study of Santowax OMP is described. The technique of calorimetry and dosimetry used in the loop studies is outlined. The results of measurements of the degradation yields, physical and chemical changes, and heat transfer of Santowax OMP are summarized. (J.S.R.)

21715 RADIOLYSIS AND PYROLYSIS OF TERPHENYLS AT HIGH TEMPERATURE. Puig, J. R.; Rosier, D.; Houllier, A. (CEN, Saclay, France). pp 385-98 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In French).

The results of static tests on the radiolysis and pyrolysis of mixtures of the three isomers of terphenyl are reported. The irradiation facility used for the radiolysis study is described. The results showed that the most stable is a mixture composed principally of o- and m-terphenyl. (J.S.R.)

21716 ADVANCES IN THE ANALYSIS OF POLYPHENYL MIXTURES. Normand, M. J.; Geiss, F. (Zentrallaboratorium der Progil S.A., Lyon. EURATOM, Ispra, Italy). pp 399-413 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In German).

Improvements made in the microdistillation method for the determination of the high-boiling fractions in polyphenyl mixtures are outlined. The combination of microdistillation and gas chromatography and gas chromatographic back washing for the determination of the high-boiling fraction is considered. Gas chromatographic determination of the high-boiling fraction using an internal standard was also studied. The results show that all three methods are suitable for the simultaneous determination of the high-boiling fraction, the terphenyls, and the diphenyls. Improvement of the stationary phase in gas chromatography is discussed. The analysis results obtained with thin layer chromatography in the determination of the high-boiling fraction are outlined. (J.S.R.)

21717 HEAT CARRIERS EXTRACTED FROM PETROLEUM. Giuliani, P.; de Gaudemaris, G. (CEN, Grenoble, France). pp 415-34 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In French).

The preparation, purification, and characteristics of the alkylphenanthrene fractions extracted from the residue of the catalytic reforming are described. The first results of irradiation studies of the alkylphenanthrene fractions are reported. These results indicate that alkylphenanthrene fractions can conceivably constitute a substitute for the terphenyls in organic cooled reactors. The alkylphenanthrenes have a better radiostability but lower thermal stability. The decomposition rate under reactor irradiation is equal at 360°C to that of OM.2 at 380°C. The C gas is approximately 10 times higher. The physical constants of the irradiated products are very close. The induced activation is better than or equal to that of the terphenyls. The fusion point is lower than that of terphenyls. (J.S.R.)

21718 STUDY AND RESEARCH ON THE POSSIBILITY OF USING SAP IN REACTORS COOLED WITH ORGANIC LIQUIDS. Buttinelli, D. (Univ., Rome); De Gregorio, G. pp 435-47 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

Four series of SAP samples containing 4%, 7%, 10.5%, and 13.5% oxide were studied with respect to their stability under thermal

cycling, stress rupture after long term annealing at 500 and 600°C, and corrosion in terphenyls. The thermal cycling studies showed the fragilization phenomenon of the structure with high oxide concentration. Structural modification occurred in the laminate samples, with greater probability with high oxide concentrations. The surface of the SAP samples underwent extensive corrosion at temperatures above 370°C. (J.S.R.)

21719 PRO RESEARCH AND DEVELOPMENT PROGRAM. Pedretti, A.; Di Menza, R.; Russo, S. pp 451-7 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

A brief outline is given of the PRO research program with emphasis on the specific conditions imposed in the study. (J.S.R.)

21720 CFP-200 EXPERIMENT LOOP. Matteuzzi, L. pp 469-79 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The CFP-200 experimental loop is designed for the determination of the thermal exchange coefficient with polyphenyl and with the geometry of various cores of the PRO reactor. The circulation system, the instrumentation, and the test components are described in detail. An outline is given of the test procedure. (J.S.R.)

21721 COMPONENT TESTING CIRCUIT FOR ORGANIC LIQUIDS. Zona, L.; Farello, G. pp 481-512 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The component testing loop is described. The test sections are inserted in parallel with other branches or singly into the turbines constituting the loop proper. These contain the testing apparatus, the control valve, the instrumentation, and the safety apparatus. These are described in detail for various test sections. (J.S.R.)

21722 FIO INSTALLATION. Bordonali, C. pp 513-22 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The FIO experimental loop was developed to find a solution to the problem of the purification of organic moderator coolants of inorganic particles produced by the corrosion of the installation. The loop is described in detail and its operation is outlined. (J.S.R.)

21723 HEAT TRANSMISSION WITH ORGANIC LIQUIDS. Pinchera, G. C. pp 523-63 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

A bibliographic study is made of the heat transmission with organic liquids. The composition and physical properties of the commercial mixtures of the terphenyls and biphenyls, the characteristics of the heat exchange of organic liquids, and the thermal design of organic cooled reactors are included. 109 references. (J.S.R.)

21724 THERMAL STUDIES ON ORGANIC HEAT CARRIERS. Ressouat, R.; Elberg, S.; Martin-Lefevre, F.; Ricque, R. (Centre d'Etudes Nucleaires, Grenoble, France). pp 565-606 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In French).

The devices used for the measurement of the physical characteristics of Santowax OMP and OM-2 up to 500°C at a maximum pressure of 20 kg/cm^2 are described. Typical results obtained on the density, viscosity, vapor pressure, and thermal conductivity are presented. The test apparatus used for the study of the thermal exchange coefficient of polyphenyls in forced convection is described. The test results are graphed and discussed. The loop used for the study of the effect of fouling on the heat transfer is described in some detail. (J.S.R.)

21725 MODERATOR DUMP GATES. Blackburn, Robert W. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,280,000. Oct. 18, 1966. Filed Jan. 27, 1965.

A dump gate is described for the moderator of a reactor of the type comprising a calandria and a dump tank beneath the calandria and adapted to receive a working volume of moderator liquid within the calandria with a sustaining gas pressure within the dump tank. The interface means for separating the liquid and gas comprise the dump gate with the gate forming the supporting surface for the liquid and defining a seal with the base of the calandria. The seal comprises a manometer tube section separating liquid in the calandria and gas in the dump tank. Pressure release in the tank upsets the equilibrium balance between pressure of the sustaining gas and pressure of the liquid on the gate opening the gate and discharging the liquid from the calandria into the tank. A number of such gates may be used within a reactor so that the area of the gates is greater than the area of flow required for emergency shutdown of the reactor. (B.L.M.)

21726 STEAM-COOLED NUCLEAR REACTOR. (to Gesellschaft fuer Kernforschung mbH.). British Patent 1,059,486. Feb. 22, 1967. Priority date May 11, 1963, Germany.

A design is given for a steam-cooled superheat reactor having a spherical core which is surrounded by a shield. The steam units are then arranged to a better advantage for this type of reactor. (M.L.S.)

21727 POWER PRODUCTION PROCESS AND SYSTEM. Maillet, Ennemond (to Commissariat a l'Energie Atomique). British Patent 1,058,518. Feb. 15, 1967. Priority date July 8, 1964, France.

A process for power production and a design for the necessary system are outlined. The process and design are applicable to gas-cooled power reactor systems. Power production by recovery in a closed circuit between reactor and gas turbine is the basis of the design. (M.L.S.)

21728 THORIUM-CYCLES IN ORGEL-TYPE REACTORS. Blaesser, G. (EURATOM-CCR, Ispra, Italy). 27p. (CONF-660524-24). DTIE. Gmelin, AED-CONF-66-104-19.

From 2nd International Thorium Fuel Cycle Symposium, Gatlinburg, Tenn.

Burn-up calculations for ORGEL-type systems with both 7 element and 19 element clusters show that the neutron economy of such Th-fuel cycles yields a very good use of the original fissile material. In fact, the number (g) of grams of fissile material effectively consumed per MWD produced is around 0.1 g/MWD for a mean specific power of ~ 70 MW_{th}/T at an enrichment of about 2.3%–2.5% ^{235}U. For lower specific powers the net consumption is even lower (and becomes negative in the case of a thermal breeder) but the economics in Th-cycles tends to favor the solutions of high specific power. The effective net consumption after a number of recycles is even lower because the fissile fuel in the discharged elements is ^{233}U which is a better fuel than the original ^{235}U. The natural uranium fuel cycle for D_2O reactors is the throw-away cycle, in which the spent fuel is stored away without recovery of the fissile material contained. Calculations indicate that the throw-away Thorium cycle does not seem to be very interesting as compared with the natural or slightly enriched uranium cycle. The economic interest of thorium fuel with ^{233}U recycle depends on the cost of reprocessing. Its advantages will appear when shortage of fissile material occurs before fast breeders have become economical producers of power. From the point of view of neutron economy there is no doubt that the Thorium cycle is superior to the uranium cycle. It will lead to a better use of the fissile resources and a reduction of the fuel consumption and inventory cost by a factor 3 or even larger. (auth)

21729 INZHENERNO-FIZICHESKIE VOPROSY YADERNYKH REAKTOROV. (Engineering-Physical Problems of Nuclear Reactors). Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. 155p.

Fourteen papers are included in the publication. Separate abstracts were prepared for twelve of the papers. (J.R.D.)

For abstracts of individual papers see: 21730–21737, 21780–21782, and 21807.

21730 UNIQUENESS OF A POSITIVE SOLUTION FOR STEADY-STATE EQUATIONS FOR NEUTRON TRANSPORT IN A STATIONARY NUCLEAR MEDIUM. Shishkov, L. K.; Shikhov, S. B. pp 3-10 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The Krein, Rutman, and Krasnoselskii theorems based on the Shawder principle of fixed point for fully continued operators were used for determining the existence of a positive solution for the steady-state equation of neutron transport. The problem is resolved with the assumption that the nuclei of the media are at rest. (R.V.J.)

21731 VARIATIONAL METHOD FOR MULTIGROUP NEUTRON FIELD SYNTHESIS IN MULTIZONE REACTORS. Khromov, V. V.; Slesarev, I. S.; Kuzmin, A. M. pp 11-32 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The neutron field in a nuclear reactor can be described with a degree of accuracy by a multi-group set of kinetic equations which are written in vector-matrix form with a P_1-approximation to avoid tedious calculations. A functional J can be composed on the basis of the neutron diffusion equations and the boundary conditions. The functional J is varied with respect to vector functions which satisfy the diffusion equation. The deviation of the functional from the exact value is a second-order difference compared with the deviation in the average vector function from the function which is a solution of the problem. The multigroup set of equations is reduced

to a set of few-group equations by the use of the variational principle and by the low sensitivity of the functional to error in the vector functions. It is assumed that the space and energy components of the neutron flux and of the neutron worths are partially separable. The solutions give approximate values of integral fluxes and neutron worths in various reactor zones in a particular energy subspace. The effective multiplication factor of the reactor is determined. (TTT)

21732 FEW-GROUP CALCULATION METHOD FOR MULTIZONE REACTORS. Kuzmin, A. M.; Khromov, V. V. pp 33-52 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The method of calculation is based on reducing a large number of neutron energy groups to a small number of groups without taking into account the neutron worth. The formalism of the method is readily extended to the kinetic, multi-group equation for neutron transfer. The distribution of neutron flux in a one-dimensional cylindrical reactor is described in vector-matrix form by a diffusion approximation. The spacial distribution of any group of neutrons is very close to the neutron distribution of neighboring groups. Only the distribution amplitudes differ. A few-group set of differential equations is then obtained for all groups belonging to an energy region. Equations for the integral neutron flux are developed. The computation of the reactor parameters are readily carried out on a digital computer. The integral neutron fluxes in various zones of single- and two-dimensional cylindrical reactors are calculated on a digital computer with the use of an 18-group system of constants, and are compared with the results obtained by the few-group method of calculation (maximum of a 4-group system of constants). With optimum combining of the groups in the energy regions, the few-group method gives accurate values of the critical mass and the breeding coefficient. (TTT)

21733 EFFICIENT ANALYTICAL COMPUTATION METHOD FOR MULTIZONE REACTORS. Shikhov, S. B.; Davydov, V. I.; Shishkov, L. K. pp 67-77 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Numerical iteration methods were used almost exclusively in calculating the parameters of multizone reactors, but these methods cause difficulties owing to slow convergence in calculating the parameters of large units. A critical set of equations of a multizone reactor with the boundary conditions is written with a m-group diffusion approximation, and is transformed to a vector-matrix form. An expression is obtained for the reactor flux in the outer reactor zone. The equations are also solved for plane-parallel geometry, and for cylindrical geometry of the reactor. The elementary functions are broken down into Taylor series at the boundary point of the i-th zone. The problem of determining the multiplication factor k_f and neutron flux in a multi-zone, single-dimensional reactor is thus solved by an analytical method not utilizing iteration. The matrix order does not depend on the number of zones. The expression can be readily programmed on a digital computer. (TTT)

21734 ANALYSIS OF REACTIVITY CHANGES AS A FUNCTION OF BURNUP DURING THE INITIAL STAGES OF FAST NEUTRON OPERATION USING INERT DILUTE FUEL. Shmelev, A. N. pp 85-9 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

In a reactor where the fissionable and breeding substances are found in two areas (core and blanket), the change in reactivity may be considerable. Thus, in a fast reactor, the positive reactivity introduced by the formation of secondary Pu does not compensate for the burn-up of primary Pu. Conversely, the increase in reactivity from the secondary Pu can be greater than the reactivity loss from the burn-up of primary Pu. The system requiring the minimum amount of compensating reactivity is regarded as optimal. A reactivity production coefficient (RPC) is defined as a ratio of the rate of increase of reactivity because of the production of secondary Pu to the rate of decrease in reactivity because of the burn-up of primary Pu. An expression is derived for the RPC value. Calculations on a digital computer show that the reactivity of a reactor with a circular active core decreases monotonically at first (RPC < 1). With increasing thickness of the circular active core the rate of fall in reactivity increases. In reactors with two circular active zones the reactivity falls monotonically, but there is an optimum thickness of the breeding zone between the two hot zones at which a maximum value in the RPC is attained (the rate of fall in reactivity is the least in this case). (TTT)

21735 SUBGROUP METHOD AND ITS REALIZATION IN A DIFFUSION APPROXIMATION. Nikolaev, M. N.; Ignatov, A. A.; Khokhlov, V. F.; Shikhov, S. B. pp 90-5 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

In a certain region it is assumed that a substance has a resonance structure where the total cross-section depends on the neutron lethargy. A method of sub-groups is used in the neutron transfer equation, where the neutron exchange takes place between all the sub-groups, that is, each sub-group gives neutron transfers into any other sub-group. In comparision with the usual multigroup method this feature results in an increase of the number of iterations during numerical solution. However, this disadvantage is compensated by the increase in accuracy of computation in the resonance region of energies. Where detailed data on the resonance structure of cross-sections are lacking, the cross-sections of subgroups in a particular region of energies can be determined from neutron transmission experiments. (TTT)

21736 CRITICAL SIZE OF SLAB REACTOR. Ivanov, L. D. pp 142-9 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

An infinite plane reactor without a reflector is considered. A set of multigroup kinetic equations and the boundary conditions are written, and a general solution of this equation is developed in the form of a set of singular integral equations which in turn are solved to give a set of M linear algebraic equations. The critical size is found from this set of solvable algebraic equations. This method can also be used to find the angular distribution of the neutrons. The critical half-thickness is calculated and found to compare well with an exact value given in the literature. (TTT)

21737 ANGULAR DISTRIBUTION OF NEUTRONS IN A SLAB REACTOR. Ivanov, L. D. pp 150-4 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A plane layer is irradiated with a neutron beam incident on the surface at an arbitrary angle. A general solution for a set of multigroup kinetic equations is obtained in the form of a singular integral equation with a Koch kernel. An expression is then derived to obtain the average cosine of the scattering angle. The angular neutron distribution in a two-layered disk can be found in an analogous fashion. (TTT)

21738 REACTORS, UK. 3rd Edition. London, Eng., United Kingdom Atomic Energy Authority, July 1966. 110p. UKAEA Free.

A complete listing of all reactors in Great Britain is given. Detailed descriptions with cutaway illustrations are presented for each reactor type. The reactors are classed according to type and presented in separate sections. (M.L.S.)

21739 IMPROVEMENTS IN NUCLEAR REACTORS. (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 1,051,136. Dec. 14, 1966. Priority date Sept. 7, 1962, Sweden.

A design for a boiling nuclear superheat reactor is given. The design differs from the normal in that the guide and support structures, which are above the core, serve as a substantially closed vessel through which the steam-generating and superheat tubes pass. The outlet parts of steam-generating tubes are also arranged above the vessel in the steam chamber. (M.L.S.)

21740 METHOD AND MEANS FOR CONTROLLING THE STARTING OF A HOMOGENEOUS NUCLEAR REACTOR. (to Allmaenna Svenska Elektriska Aktiebolaget). British Patent 1,051,339. Dec. 14, 1966. Priority date Sept. 25, 1962, Sweden.

A design is given for a homogeneous power reactor which reduces the start-up difficulties. This is done by use of a minimum number of parts during startup. The reactor is comprised of a reactor containment vessel, and sub-critical storage tanks and collecting vessels. The fluid-fuel composition is circulated throughout the system by a pressurized gas. (M.L.S.)

21741 NON-ITERATIVE NUCLEAR-THERMAL INTERACTION METHOD. Sha, William T. (Westinghouse Electric Corp., Pittsburgh). 6p. (CONF-651101-86). DTIE. Gmelin, AED-CONF-65-332-144.

From 13th Conference on Remote Systems Technology, Washington, D. C.

A calculational procedure for determination of neutron flux distribution and coolant density profile for light-water moderated reactors is given. By use of coolant enthalpy, rather than void fraction, as the independent variable, analysis is extended to the pressurized-water reactor core as well as the boiling water reactor core. This method is a one-dimensional one-group noniterative analysis. The one-group analysis can be extended to a two-group analysis and solved by the computer code, ANDREA. (M.L.S.)

21742 INFLUENCE OF MODERATOR-TEMPERATURE GRADIENTS ON CAVITY-CORE REACTORS. Williams, Michael Donald. Los Angeles, Univ. of California, 1966. 108p.

Thesis.

A moderator temperature gradient produces a spatially dependent neutron spectrum. The space dependent neutron spectrum produces a space-dependent average, thermal-absorption cross section which influences the critical parameters of a cavity-core reactor. This problem is studied by means of an approximation whereby the thermal neutron spectrum is represented by a continuum of overlapping Maxwellian distributions. This technique reduces the problem of the thermal group description to solving an integral equation. The integral equation is solved in the case where the average absorption cross section varies slowly over distances of the order of the characteristic distance for neutron energy change. The results show that a moderator temperature gradient can have a significant influence on the critical mass, minimum critical radius, and the variation of the effective multiplication factor with temperature of a spherical, cavity-core reactor. (auth)

21743 SMALL NUCLEAR POWER PLANTS FOR LATIN AMERICAN AND OTHER DEVELOPING AREAS. Smith, Craig Byron. Los Angeles, Univ. of California, 1966. 347p.

Thesis.

The role of small nuclear power plants in economic development has been explored by studying regional power needs and their implications for power plant design. A projection of the world's requirements for nuclear power plants was made on the basis of a brief study of thirty-two countries. Emphasis was given to the future energy requirements of Latin America, and included the potential impact of Rural Industrial Technical Assistance (RITA) industrialization programs. It was estimated that the market for small 10 MW(e) nuclear plants will be about thirty plants per year during the coming decade if means of financing are available and if the plants can sell power at 20 mills/kwh or less. (auth)

Marine and Portable Power Reactors

21744 NEUTRON EXPOSURE OF THE PM-2A REACTOR VESSEL. Shure, K.; Oberg, Carl T. (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 27: 348-59(Feb. 1967). (WAPD-T-1882).

An irradiation exposure profile was calculated and subsequent experimental measurements using nondestructive dosimetry procedures were obtained for the reactor pressure vessel of the Portable Medium Power Plant (PM-2A). Near the core centerplane at the inner edge of the vessel, the maximum calculated exposure is 1.6×10^{19} n > 1 MeV/cm^2 and the maximum calculated activity from the ^{54}Fe(n,p)^{54}Mn reaction is 1.9×10^7 dis/(cm^3 sec) as of July 9, 1965. The average of calculated-to-measured ^{54}Mn activity for 25 azimuthal locations at the core centerplane is 1.05. This agreement is within the uncertainties of either the calculated or experimental results. (auth)

21745 NUCLEAR MARINE PROPULSION. Higson, D. J. (Atomic Energy Commission, Australia). At. Energy Austral., 9: No. 4, 2-10(Oct. 1966).

Nuclear propulsion of submarines and naval surface vessels is reviewed along with commercial maritime uses. Developments in Britain, U. S. and other countries are noted and economic aspects are discussed. Applications to Australian trade are examined. (J.R.D.)

21746 SHIPBOARD REACTOR SHIELD OPTIMIZATION USING THE OPTIMUM GRADIENT METHOD. Terney, William B.; Fenech, Henri (Massachusetts Inst. of Tech., Cambridge). Nucl. Appl., 3: 46-52(Jan. 1967).

The optimum gradient technique is reviewed and then used to optimize a shipboard reactor shield system consisting of a water-lead primary and a concrete-lead-polyethylene secondary shield. The shield is optimized to the point where the cost of further reductions in weight exceeds the worth (K) of these reductions to the ship, and subject to five dose point constraints. Plots of eight thicknesses as a function of K are given. For high K values (essentially weight optimization) the concrete thicknesses are zero. As K decreases and cost becomes more and more important in comparison to the weight, concrete is added, and the more expensive lead and polyethylene are subtracted. (auth)

21747 IMPROVEMENTS IN NUCLEAR VAPOR GENERATING INSTALLATIONS. (to Babcock and Wilcox Co.). British Patent 1,051,135. Dec. 14, 1966. Priority date Aug. 23, 1962, United States.

A design is given for a reactor which can be used as a vapor generator. The design includes a baffle which defines the upward flow path of the coolant, a down flow path which goes laterally around the reactor, a vapor generating heat exchanger in the down flow path through which a secondary coolant fluid is passed, and a primary coolant circulator placed outside the pressure vessel. (M.L.S.)

Rocket and Space Reactors

Refer also to abstracts 19820, 19840, 20471, 20473, 20608, 20999, and 21801.

21748 (IDO-17205) SNAPTRAN EXPERIMENTAL MEASUREMENTS AND INSTRUMENTATION. Berta, V. T. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Jan. 1967. Contract AT(10-1)-205. 174p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The SNAPTRAN experimental program provides nuclear safety information applicable to SNAP 10 A/2 reactor systems. The specific designations for the programs are SNAPTRAN-1 for the kinetics studies in the nondestructive region, SNAPTRAN-2 for the kinetic studies in the destructive region, and SNAPTRAN-3 for the safety studies involving reactor destruction due to water immersion. A detailed description of the experimental measurements and instrumentation used to obtain data from the tests is given. Also included are detailed descriptions of the reactor systems and the theoretical analyses which formed the basis for the experimental measurements and instrumentation. (auth)

21749 (NAA-SR-Memo-10183) SNAP-8 FUEL ELEMENT FABRICATION AND PERFORMANCE TESTING. (Atomics International, Canoga Park, Calif.). [nd]. Contract AT(11-1)-Gen-8. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The procedure of the fabrication of Snap fuel elements is pictorially presented. The fuel element performance during testing is briefly described. (J.C.W.)

Process Heat and Desalination Reactors

Refer also to abstracts 21636 and 21655.

21750 (ACNP-65568) STUDY OF SPECIALTY-TYPE BRINE HEATERS FOR DUAL-PURPOSE BWR PLANTS. Swanson, David H. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). July 1965. 12p.

The relative effectiveness and cost of various leakage-control methods are evaluated in a specialty-type heat exchanger for dual-purpose BWR plants. To establish a basis of comparison, a reference brine heater was sized using conventional practice and using 18 gage Cu-Ni tubes. Calculations were performed using both ¾-in.-dia tubes and 1-in.-dia tubes. (J.C.W.)

21751 (ORNL-TM-1586) USE OF THE EVAPORATOR TO AUGMENT REACTOR CONTAINMENT IN LARGE NUCLEAR DESALINATION PLANTS. Arnold, H. G.; Gall, W. R.; Tripp, A. M. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The possibility of using the seawater evaporator of large nuclear desalination plants as a part of the reactor containing system was investigated. Preliminary concepts of plants in which the evaporator is used as a shell for double containment and as a pressure suppression chamber were developed and evaluated. The estimated cost of the conceptual plants is less than that of the reference plant, but this cost advantage may be partially offset by a possible increase in the cost of the evaporator portion that might be required to make it meet nuclear standards. However, the improved safeguards of these plants may reduce the magnitude of the problems related to siting nuclear desalination plants by reducing the area required for the more compact plant and allowing it to be located closer to population centers, thus reducing the distance required for product conveyance. (auth)

21752 (CEA-tr-R-1538) ATOMIC POWER PLANT BN-350. Leipunskii, A. I.; Kazachkovskii, O. D.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated into French from Russian report. 46p. (In French). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $4.60 fs, $1.58 mf.

The BN-350 fast neutron power reactor is designed to produce 150 MW electricity and produce 1200 tons of vapor/hr for the feed of a water desalination installation. The completion of construction and start-up is scheduled for 1968-1969. The reactor is

fueled with a mixture of uranium dioxide and plutonium clad for oxidation protection. The functional constituents of the reactor such as core and shields, reactor vessel, control and safety systems, loading-unloading system, reactor protection, construction materials, and heat exchange system are described. (J.S.R.)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 19793, 19964, 20561, 21655, and 21738.

21753 (AERE-R-5168) BEAM INTENSITY MEASUREMENTS ON THE DIDO COLD NEUTRON APPARATUS. Cocking, S. J.; Webb, F. J. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1967. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 3s. 6d.

The inpile section of the liquid H_2 loop in DIDO was replaced during 1965. The results of beam measurements over a range of neutron wavelengths made on the earlier loop and its replacement are given. The flux gain obtained with use of the liquid H_2 moderator was 6 for 4.2 Å neutrons, increasing to 11 for 8 Å neutrons. Despite modification to the shape and volume of the moderator chamber these gain figures differ little between the two loops. Attempts were made to fit the observed spectra and gain factors using both single and two component Maxwellian spectra. Measurements of the gain in flux by liquid N_2 cooling the polycrystalline Be beam filters are also reported. The observed flux gain factor for 4.1 Å neutrons on cooling was 3.9, 20% lower than was calculated from published cross section data. The overall fluxes with the new equipment are higher than those obtained earlier; the improvement ranges from 50% at 4.1 Å to more than 100% at longer wavelengths. (auth)

21754 (ANL-6841) SAFETY ANALYSIS ASSOCIATED WITH THE PLUTONIUM RECYCLE EXPERIMENT IN EBWR. Toppel, B. J.; Vogelberger, P. J. Jr.; Wimunc, E. A. (Argonne National Lab., Ill.). Nov. 6, 1964. Contract W-31-109-eng-38. 106p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Pu recycle experiment is described in detail. General plant improvements are described. These are the result of previous experiments in the EBWR. The operational procedures and safety considerations are discussed. Stability, radiation damage in the pressure vessel, and characteristics of special experimental fuel rods for the Pu zone are discussed in the appendixes. (J.C.W.)

21755 (ANL-7302) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, JANUARY 1967. (Argonne National Lab., Ill.). Feb. 24, 1967. Contract W-31-109-eng-38. 106p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

EBWR has been operating at a steady power of 42 MW since November 11, 1966. The reactor will be shut down in February 1967 so that special fuel pins can be removed for isotope analysis. In preparation for Run No. 25, the EBR-II core size was increased from 81 to 91 subassemblies. Since the enlarged core has moved additional driver fuel out to Row 6 locations, the question of relatively high gamma heating in blanket Rows 7 and 8 has assumed new importance. Therefore, detailed calculations of expected temperatures and examination of blanket elements and their contained depleted U which have achieved varying degrees of burnup are being made before initiating Run No. 25. In addition to routine processing and fabrication of fuel subassemblies at the Fuel Cycle Facility an Argon Cell electromechanical manipulator was repaired in-cell, with special tools, and an Air Cell crane trolley which was transferred to the cell roof enclosure for repair. The Mark-IB modified fuel restrainer was tested with a new thinner shank. Fabrication of 3 experimental subassemblies, 7 special subassemblies with the materials therein controlled for later evaluation, and 5 subassemblies of the half-worth type for use in making reactivity adjustments in the reactor are also reported. Experiments were continued in ZPR-3 Assembly 48, a Pu-fueled critical assembly with a distribution of materials similar to a large carbide reactor. This assembly is being used to make measurements relevant to the FFTF design. Heterogeneity measurements were made using thin ^{235}U, ^{238}U, and manganese foils in several configurations. Relative ^{238}U capture rate was measured at seven positions near the core midplane, using a method developed at ZPR-3. Excavation of the ZPPR reactor pit is complete. The six reactor pit posts have been steel capped and the concrete tops for them have been poured. The AFSR reactor pit and room foundations have been poured. Placement of structural steel for the support wing is 95% complete. The precast concrete floor of the support wing is in place and all walls and support columns of the vault, workroom, and inside equipment rooms have been poured. A supplement to the AARR Preliminary Safety Analysis Report was completed. (J.R.D.)

21756 (APDA-186) ALTERNATE REACTOR CONCEPT DESIGN STUDY FOR THE FAST FLUX TEST FACILITY. Alternate Skewed-Core Reactor Concept. Duffy, J. G.; Hess, J. W.; Mueller, R. E.; White, J. R. (Atomic Power Development Associates, Inc., Detroit, Mich.). Apr. 30, 1966. Contract AT(11-1)-865. 95p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Battelle-Northwest, Richland, Wash.

Significant features and characteristics of an alternate reactor concept for the Fast Flux Test Facility (FFTF) and a comparison with the FFTF interim reference reactor design is made. Cost estimates of the alternate reactor concept are given to allow comparison with the interim reference concept reactor. A discussion of reactor performance factors and confidence considerations is given. Layout studies pertinent to comparative evaluation of the interim reference concept reactor and alternate reactor concept are presented. (M.L.S.)

21757 (CONF-651154-5) MONITEUR DE FLUX THERMIQUE A CIRCUIT GAZEUX. (Monitor for Thermal [Neutron] Flux of Gaseous Circuits). Pleyber, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov. 3, 1965. 9p. (In French). Dep. mn.

From Symposium on Flux Measurements used in Connection with Irradiation Equipment in Research and Material Test Reactors, Grenoble, France.

An apparatus for the continuous measurement of the thermal neutron flux by gas circulation was described. Only relative measurements are considered and the sensitivity of the device is given by association with a measurement by classic activation. The precision of these measurements is 2%. Two examples for the corresponding application to experimental loops irradiated in the swimming pool reactors Melusine and Siloe are cited. (tr-auth)

21758 (CONF-660511-, pp 6,4,1-31) POWER AND FUEL DEPLETION CALCULATIONS FOR NON-INSTRUMENTED CAPSULES IN NASA'S PLUM BROOK REACTOR FACILITY. Schreiber, R. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.).

A method has been developed for determining depletion and power in fuel-bearing capsules as functions of time. The method is suitable for hand calculations, or may be programmed for machine computation. Key to the method is an adequate series of flux perturbation measurements to determine the empirical factors in the formulas. A simplified method is given for treating burnable poisons, such as boron-10, used in conjunction with the experiment. The basic equations are included along with descriptions of capsule design and the mock-up reactor at the Plum Brook Reactor facility. (J.R.D.)

21759 (CONF-660511-, pp 6,2,1-10) EFFECT OF REACTOR CORE CHANGES ON NEUTRON SPECTRA. Helm, J. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Several variations of the loading of the GETR core in positions adjacent to the D7, E7, and F7 positions in which graphite capsules are irradiated were analyzed. In general, changes in materials within the irradiation position perturb the neutron spectra, change the fast flux intensity, effect the effective cross sections for flux monitoring materials, and change the number of displacements occurring. However, changes made in the adjacent positions produce smaller perturbations, with the exception of drastic changes, such as replacing control fuel with poison. The results point out that with knowledge of the neutron spectra and effective cross sections that the flux, $E > 0.18$ MeV, provides an accurate indication of the damage to the graphite even when large variations in reactor loadings occur. The results also show that once the detailed neutron spectra and effective cross sections are determined for an experiment they will continue to be valid even though large variations in core loadings are made in adjacent reactor positions. (auth)

21760 (CONF-660511-, pp 2,5,1-17) THERMAL FLUX CALCULATIONS FOR EXPERIMENTS IN THE MTR. Buck, J. S. (Atomics International, Canoga Park, Calif.).

Calculational techniques used successfully in predicting experiment operating power in the MTR are presented. An example of the use of these techniques is included. (J.R.D.)

21761 (CONF-660511-, pp 3,5,1-4) ASSEMBLY FOR IRRADIATION OF MOLTEN FLUORIDE FUEL TO HIGH BURNUPS IN THE OAK RIDGE RESEARCH REACTOR (ORR). Savage, H. C.; Baker, J. M.; Kelly, M. J.; Compere, E. L. (Oak Ridge National Lab., Tenn.).

The design of an irradiation assembly is described for use in experiments to study the effects of irradiation and fissioning on molten fluoride fuel salt and construction materials. The experimental conditions simulate those expected to exist in an operating molten salt reactor. (J.R.D.)

21762 (CONF-660511-, pp 3.8.1-21) DESIGN, ASSEMBLY, AND OPERATION OF URANIUM ZIRCONIUM-HYDRIDE FUEL IRRADIATIONS. Kinzer, J. E. (Atomics International, Canoga Park, Calif.).

An irradiation experiment, designated NAA 115-1, consisting of six separate experiments in series, each having independent instrumentation and control systems, is described. Two of the experiments have four sublength fuel elements, while each of the other four experiments have one sublength fuel element, for a total of 12 specimens. The number of experiments is determined by the number of operating temperatures of interest. The number of specimens in each experiment is determined by the number of variables which are to be investigated at that particular operating temperature. (J.R.D.)

21763 (JAERI-1120) JRR-4. Shindo, Mitsuo (ed.) (Japan Atomic Energy Research Inst., Tokyo). Aug. 1966. 95p. (In Japanese). Dep. mn.

Characteristic tests of experimental facilities of JRR-4 were done. Data of these tests for Dry Shielding Test Facility, No. 1 Pool Facility and Lid Tank Shielding Facility are presented. Although all characteristics of the facilities were not tested, the most urgent data for the future use of these facilities were obtained and reported. (auth)

21764 (JAERI-1121) FISSION GAS RELEASE LOOP. Kamemoto, Y.; Shiba, K.; Handa, M.; Yajima, S. (Japan Atomic Energy Research Inst., Tokyo). Aug. 1966. 49p. (In Japanese). Dep. mn.

In a power reactor, the high burn-up and high-temperature operation of fuel are desirable. The accumulation of fission products produced by burning the nuclear fuel is responsible for distortion, damage and rupture of the fuel, because the fission products are different substances from the fuel. These effects become larger as the burn-up and burning temperature are increased. The Fission Gas Release Loop is for the study of the behaviors of fission Xe, Kr and I and other impurity gases, which affect the nuclear reactor safety. The loop consists of two main parts, i.e., the in-pile (plug) and out-pile portions. A plug is inserted in the vertical experimental hole VC-3 of the Japan Research Reactor No. 3(JRR-3). A specimen chamber is installed at the top of an inner plug, surrounded by heat reflector or insulator and cooling-water jacket. The neutron flux at the specimens is about 6×10^{12} n/cm^2·sec and the fuel specimen can be heated to an arbitrary temperature and up to 1,000°C by the combined action of its own fission and a Pt wire heater. The out-pile portion consists of out-pile apparatuses I, II, and III, cooling water and control systems, off-gas tank, γ-ray spectrometer and gas chromatograph. By means of the apparatuses, it is possible to control the irradiation condition of specimens and to analyze the fission Xe, Kr and I, and impurity gases released from the fuel specimen. Details of each apparatus, shield calculation and hazard analysis are reported. (auth)

21765 (KFK-471) CONSTRUCTION AND EXPERIMENTAL EQUIPMENT OF THE KARLSRUHE FAST CRITICAL FACILITY, SNEAK. Engelmann, P.; Bickel, W.; Daeunert, U.; Habermann, F. W. A.; van Velze, P. L.; Walze, H.; Wittek, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Oct. 1966. 33p. Dep. mn.

A description of the design features and experimental equipment at the facility is given, and the methods used for precise reactivity measurements in the facility are described. SNEAK is a fixed vertical assembly with fuel elements suspended from a top grid. Horizontal and vertical channels may be formed in the reactor. The two horizontal channels are used for a material replacement drawer with automatic sample changer, a detector or material traverse device, and a pulsed neutron source. Four vertical channels close to the core center are available for installation of a pile-oscillator. A gas-heated loop is being constructed for Doppler experiments. Methods used in SNEAK for precise reactivity measurements including the asymptotic period method, the pile oscillator method, the inverse kinetics method, and the autorod method are compared. Details are given about the equipment and data treatment, in particular about measurements in the presence of a spontaneous neutron source. Signals from linear pulse or ionization chamber channels may be collected either by a four channel data acquisition system or a 256 channel analyzer. A special technique for storing periodic signals enables elimination of linear drift. (auth)

21766 (NP-16497) ETUDE THERMIQUE DE L'AUGMENTATION DE PUISSANCE DE SILOE. (Thermal Study of the Power Increase in Siloe). Merchie, F. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec. 7, 1965. 57p. (In French). Dep. mn.

The present operational conditions of Siloe are summarized and the conditions for power increase are given. A thermal calculation is made for the Si-23 fuel element. The study showed that the power increase would not pose any particular problems. The adoption of the two-pronged rod and of the element with 23 plates is sufficient to improve the performance of Siloe adequately. (J.S.R.)

21767 (NP-16581) UTILISATION DU SPECTROMETRE A TEMPS DE VOL TYPE S.E.P.P. POUR L'ETUDE DE SPECTRES DE NEUTRONS ISSUS DE MODERATEURS SPECIAUX DANS LA PILE SILOETTE. (Use of a Time-of-Flight Spectrometer Type S.E.P.P. for the Study of the Spectra of the Neutrons Coming from the Special Moderators of the Siloette Reactor). Ageron, P.; Chaffard, J. P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 16p. (In French). Dep. mn.

A device placed in the Siloette reactor will make it possible to emit a horizontal beam of neutrons from different types of moderators (for example, heavy water at room temperature, liquid H_2, graphite, or BeO at high temperature). The different thermal neutron spectra obtained can be studied by means of the SEPP spectrometer used either at its maximum speed or at a lower speed. This first study attempts to predict the number of neutrons detected per second and per channel. It will be of the order of several neutrons per second for the equilength channels of the burst. (tr-auth)

21768 (NP-16623) MESURES DE DEPRESSION DE FLUX DANS SILOETTE (COEUR 26-1B). (Flux Depression Measurements in SILOETTE (Core 26-1B)). Roche, D. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar. 26, 1965. 17p. (In French). Dep. mn.

A series of irradiations were made in SILOETTE in order to determine the thermal flux depression in three stainless steel tubes, an Al cylinder, and a mockup containing a stainless steel cylinder in a sealed stainless steel tube. For each sample the perturbed and non-perturbed thermal flux distributions were measured at the median plane along two perpendicular directions cutting through the center of the irradiation hole. A vertical distribution was also studied in the steel tube. The data are graphed and show that the scattering theory applied to thermal flux depressions gives good results for the stainless steel tubes. If the tubes are placed far from the reactor core at a distance that the moderator can be taken as an infinite medium, it is the variation of the absorbent and scattering properties which creates the flux depression. For cylinders placed near the core the absence of slowing down decreased the flux depression by a factor that can attain 25%. (tr-auth)

21769 (NP-16624) MESURES DE DEPRESSIONS DE FLUX ET D'ANTIREACTIVITES SUR MAQUETTES DANS SILOETTE. (Measurements of Flux Depressions and Antireactivities in SILOETTE Mockups). Roche, D. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec. 22, 1964. 35p. (In French). Dep. mn.

In order to determine a method for the calculation of the thermal flux depression created by an experimental device placed in the reflector of a swimming pool reactor, the thermal distributions were measured at the interior or different mockups of cylindrical geometry. From these distributions a mean flux depression in the device can be deduced and connected to the antireactivity that is determined by stabilization or divergents. The general measurement methods are outlined and the irradiation devices are described. (J.S.R.)

21770 (ORNL-TM-1791) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, JULY, AUGUST, AND SEPTEMBER OF 1966. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). Mar. 1, 1967. Contract W-7405-eng-26. 51p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The ORR operated 83.6% of the time during the quarter, accumulating 2286 MWd at an average operating power level of 29.7 MW. The quality of both the pool and reactor water showed considerable improvement as a result of the recent replacement of resins in the demineralizer systems. There were twenty shutdowns, five of which were scheduled for training purposes. Total downtime increased unexpectedly because of the failure of the Molten Salt experiment (42 hours) and because of flood damage to electrical equipment in the primary and secondary pump houses (55.7 hours). The instrumentation for the facility continued to operate quite satisfactorily although considerable difficulty has been experienced with the mechanical portion of the fission chamber drives. The Al-Cd shim-safety rods, used in core position F-4 and F-6, were found to be bent or bowed and were removed from service. Fast neutron damage, similar to that suffered by Be, is suspected as being the cause of the deformation of the Al. Shim-rod vibration, and the accompanying slight power oscillation, was further investigated and was found to be dependent upon shim-rod position. The evidence indicates that much of the problem is related to shim rod No. 3 (core position B-4). As a part of this work, the lower shim-rod bearings were sized (functional

check) and found to be satisfactory. No significant experiment assignment or lattice configuration changes were made. (auth)

21771 (ORNL-TM-1811) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, OCTOBER–DECEMBER OF 1966. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). Mar. 23, 1967. Contract W-7405-eng-26. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two 100 MW fuel cycles were completed and a third is in progress. The fuel elements are producing in excess of 2200 MWd of power during each cycle. Six shutdowns occurred and two of these were end-of-cycle shutdowns. However, the operating-time percentage dropped because of the extended shutdown required to investigate the control-plate bearing failure. New control plates with modified bearings were installed in the reactor after the bearings of the original set incurred excessive wear. (auth)

21772 (RT-FI-(66)20) ESPERIENZE DI CINETICA SUL R.O.S.P.O. CON IL METODO DELLA SORGENTE PULSANTE ENDOGENA. (Kinetic Experiments on the ROSPO Employing the Endogenous Pulsed Source Method). Pacilio, N.; Ferrari, T. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 37p. (In Italian). Dep. mn.

Experimental results of prompt neutron–time decay–eigenvalue and reactivity coefficient measurements in the R.O.S.P.O. reactor are reported. The results were obtained using a technique named endogenous pulsed source method because no external input is necessary, since the reactor itself triggers the time analysis of its spontaneous bursts. The method is shown to be valid within a wide reactivity range (from criticality to 13 $) and appears to be consistent with various stochastic techniques previously adopted to measure the same parameters. (auth)

21773 (RT/ING-(66)-19) MODIFICA DELLA COLONNA TERMALIZZANTE DEL REATTORE RC-1 PER L'AUMENTO DI POTENZA AD 1 MW. (Thermalizing Column Modification for RC-1 Reactor Improvement). Focaccia, G.; Loizzo, P.; Marsili, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 16p. (In Italian). Dep. mn.

In the thermalization column of the RC-1 reactor, the external graphite block was replaced with heavy water. The normalized flux resulting from this change and the relative cadmium ratios obtainable were calculated. Diagrams are given of the thermalization column before and after modification. (J.S.R.)

21774 (STI-PUB-125(Vol.6)) DIRECTORY OF NUCLEAR REACTORS. VOL. VI. RESEARCH, TEST, AND EXPERIMENTAL REACTORS. (International Atomic Energy Agency, Vienna (Austria)). July 1966. 238p. IAEA: $7.00; S 147,-; £ 2.2.0; F Fr 28,-; DM 24,50.

Supplement to Vols. II, III, and V.

Information is presented on 62 reactors in 14 countries that are in operation or under construction. The reactors are grouped according to their moderators. For each reactor type information is presented on physics parameters, core and fuel elements, core heat transfer, control systems, reactor vessels, reflectors, shielding, containment, costs, and fluid. Information on experimental facilities is also included along with sketches of reactor components and auxiliaries. (J.R.D.)

21775 (UJV-1660) FLUX FLATTENING BY MEANS OF A NON-UNIFORM FUEL DISTRIBUTION IN A SLAB REACTOR WITH FINITE REFLECTOR. Hron, M.; Lelek, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Nov. 1966. 10p. Dep. mn.

Dependence of critical size and fuel concentration upon the dimension of a reflector under the condition of a flattened thermal flux is investigated in a slab reactor described by mean of two-group equations. Space dependence of the resonance escape probability p(x) is considered. It appears that the critical size and fuel concentration increases with the decreasing thickness of the reflector. In consequence of the dependence upon the concentration of fuel, there exists a certain minimum thickness of reflector within which the requirement of the flattened thermal flux can be fulfilled. The concentration of fuel, very low for infinite reflector, reaches concentrations commonly used in power reactors for the dimensions of reflector which are near to minimum. (auth)

21776 (ORNL-tr-1513) DETERMINATION OF THE FLUX DENSITY CORRECTION FACTOR DETERMINED BY THE GEOMETRY IN A MODEL TEST IN GEESTHACHT. Wueneke, C. W. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report ABS-THH-1005a. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Appendix to ABS-THH-1005.

The deviations of the radiation flux within the shielding material are estimated because irradiation in Geesthacht is conducted with a smaller source than will be conducted later with the power reactor. The spatial flux distribution is presented for source disks with different radii under gamma radiation and with fast neutrons using the GMAR program. (J.C.W.)

21777 (ORNL-tr-1517) CALCULATION OF SECONDARY GAMMA RADIATION FOR A MOCKUP OF A POWER REACTOR SHIELD FOR THE GEESTHACHT RESEARCH REACTOR (FRG) WITH THE GRACE I COMPUTER PROGRAM. Sasse, S.; Schubart, H. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report ABS-THH-1010. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $3.60 fs, $1.37 mf.

A mock-up of a layered power reactor shield was irradiated in the Geesthacht Research Reactor. Calculated and measured data are recorded. The study deals with the calculation of the secondary gamma flux, induced by neutron capture, in a special material configuration with the aid of the GRACE I computer program. (J.C.W.)

21778 RESEARCH AND TRAINING REACTOR IR-100. Bulkin, Yu. M.; Zhirnov, A. D.; Zhemchuzhnikov, G. N.; Konstantinov, L. V.; Nikolaev, V. A.; Stenbok, I. A.; Lobanov, V. S.; Khryastov, N. A.; Filippov, A. G. At. Energ. (USSR), 21: 363-8(Nov. 1966). (In Russian).

The construction, physical-engineering characteristics, and experimental facilities of the research reactor IR-100 with thermal capacity of 100 kW(t) are described. The reactor is designed for scientific studies and for training specialists in the atomic energy field. (tr-auth)

21779 EFFECT OF CORE CHANGES ON NEUTRON SPECTRA AND MATERIAL DAMAGING RATES. Ulseth, J. A.; Helm, J. W. (Battelle-Northwest, Richland, Wash.). Nucl. Appl., 3: 233-9(Apr. 1967).

A study was made to determine the changes in fast flux intensity and spectra in several irradiation positions of the General Electric Test Reactor caused by varying the material composition in an irradiation cell or in surrounding reactor positions. The material changes are typical of those that could be expected to occur during a long-term irradiation in a test reactor. It has been concluded that material changes within an irradiation cell do perturb the fast neutron spectrum and change the fast flux within that cell. Changes made in surrounding cells do not significantly alter the spectrum in the irradiation cell. Consequently, the fast flux based on the spectral-averaged cross section and the damage indexes used for correlation of data on materials are not altered significantly. Therefore, once a detailed spectral calculation has been made, a new calculation is not required for each change in core loading. (auth)

21780 METHOD FOR CALCULATING RELAXATION LENGTHS OF ASYMPTOTIC SPECTRA. Shikhov, S. B.; Ignatov, A. A. pp 96-106 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A direct method of calculating the relaxation length of the asymptotic neutron spectrum is given for a weakly multiplying medium by a multigroup P_n-approximation with all details of the scattering being taken into account. A plane source of neutrons irradiates a semi-infinite, homogeneous, weakly multiplying medium. A function of the neutron flux distribution is defined at a large distance x from the source in terms of the relaxation length L: $\psi(x,u,\mu) \sim \exp(-x/L)\, A(u,\mu)$. Here μ is the cosine of the angle between the neutron direction and abscissa. This equation is substituted into the neutron balance equation with plane geometry. Elastic scattering, inelastic scattering and fission are taken as the three main types of interaction of the neutron with nuclei. The equations are readily programmed on a digital computer. The distributions of groups of neutron fluxes per unit of neutron lethargy are given for a P_1-approximation and for a P_3-approximation. (TTT)

21781 TRANSPORT EQUATION TAKING INTO ACCOUNT DELAYED NEUTRONS. Kryanev, A. V. pp 107-14 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A set of integral-differential equations is written for the neutron transport with delayed neutrons being taken into account in a multiplying medium. The boundary conditions assume an arbitrary configuration with no reflector. A solution in closed form is obtained by transforming to an equation in Banach space which is a normed vector space. (TTT)

21782 STUDY OF THE EFFECTS OF HETEROGENEITY OF THE MEDIUM ON MODERATION OF NEUTRONS IN IRON–WATER AND ALUMINUM–WATER MIXTURES. Yurova, L. N.; Polyakov, A. A. pp 133-41 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The spatial distributions of moderated neutrons were measured in a cylinder 41 cm in dia and 110 cm high made of thin stainless steel covered with Cd 0.5 mm thick. Metallic rods were mounted in the cylinder which was filled with water. A Po–Be neutron source was mounted at 12 to 15 cm from the bottom or from one of the sides. The cylinder was placed in a graphite prism 180 × 180 × 180 cm^3. The activity induced in an In foil having a thickness of 90 mg/cm^2 was used as a measure of the thermal neutron concentration. Spatial neutron distributions were found for volume ratios of V_{Fe}/V_{H_2O} of 1 : 3, 2 : 3, 1.31 : 1 and V_{Al}/V_{H_2O} = 1 : 3. The dia of the metallic rods were d = 10 mm and 40 mm for Fe, and d = 12 mm for Al. No difference in neutron spatial distribution could be observed parallel or perpendicular to the rods with slight heterogeneity of the medium (d = 10 mm for Fe and d = 12 mm for Al). On the other hand, the spatial neutron distribution in two mutually perpendicular directions was anisotropic with high heterogeneity of the medium (d = 40 mm for Fe). The square of the neutron slowing down length was calculated for the various mixtures with the use of a method of moments by means of a multigroup computation. The calculated values were smaller than the experimental values in the anisotropic media. (TTT)

21783 RESEARCH ON REACTOR WATER LOOP. Veselkin, A. P.; Nikitin, A. V.; Orlov, Yu. V. At. Energ. (USSR), 21: 509-11(Dec. 1966). (In Russian).

The experimental water-cooled and moderated reactor was provided with a loop containing several radiation emitters. High-purity water was pumped through the reactor core where it was activated as a result of the ^{16}N formed by the $^{16}O(n,p)^{16}N$ reaction, passing afterwards over the γ sources. The activated water was passed from the center toward the periphery of disk-shaped tubular windings. The tests included measurement of the linear activity and measurement of the activity at certain distances from the plane of the windings. The concentration of the various chemical forms of ^{16}N in the reactor water was measured. At 20°C, pH values were between 6.4 and 6.9, the concentration of the anionic form (NO_2^-, NO_3^-) was found to be 60%, that of the cationic (NH_4^+) form was 15%, and the neutral form (NO, NO_2, N_2, $NH_3 \cdot H_2O$, etc) was 25%. (TTT)

21784 BEAMS OF POLARIZED NEUTRONS IN THE INSTITUTE OF NUCLEAR RESEARCH OF CZECHOSLOVAK ACADEMY OF SCIENCES. Kajfosz, J.; Kopecky, J.; Michalec, R.; Vavrin, J.; Chalupa, B.; Holecek, J.; Vavra, J. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). pp 138-9 of Proceedings of the 2nd International Symposium on Polarization Phenomena of Nucleons. Huber, P.; Schopper, H. (eds.). Basel and Stuttgart, Birkhaeuser Verlag, 1966.

Two arrangements for neutron polarization which were installed at the reactor WWR-S are briefly described. The first polarized neutron beam was obtained by the method of total reflection of slow neutrons on a magnetized cobalt mirror. The second polarized beam was produced by means of diffraction of neutrons on a magnetized Co-Fe crystal. (L.B.S.)

21785 NEUTRONICS CHARACTERISTICS OF CERMET AND CERAMIC DRIVER FUELS FOR THE FAST TEST REACTOR (FTR). Little, W. W. Jr.; Hardie, R. W. (Pacific Northwest Lab., Richland, Wash.). Nucl. Appl., 3: 26-31(Jan. 1967).

The neutronics characteristics of four possible driver fuels for the Fast Test Reactor (FTR) are compared. The fuels investigated are PuO_2–SS and UO_2–SS cermets and PuO_2–$^{238}UO_2$ and UO_2–$^{238}UO_2$ ceramics. Since a high flux is of paramount importance in a test reactor, low-inventory Pu-fueled cores are found to be quite attractive for use in the FTR. For core volumes of approximately 600 liters, cermet fuels offers a higher neutron flux and a larger shutdown coefficient than oxide ceramic fuels. If the latter fuels are used, BeO could be added to enhance the Doppler coefficient. (auth)

21786 DESCRIPTION OF THE CIRO ORGANIC COOLED IRRADIATION CIRCUIT. Gerosa, A.; Cafaggi, E.; Sartorelli, F. pp 459-68 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The CIRO (organic cooled radiation circuit) for the testing of fuel elements is described in detail. The characteristics of the primary, secondary, and purification circuits are given. (J.S.R.)

21787 ZERO POWER EXPERIMENT ORGANIC REACTORS. Barabaschi, S.; Bianchi, G. pp 607-22 of Reattori a Liquido Organico. Rome, Comitato Nazionale Energia Nucleare, 1964. (In Italian).

The design and characteristics of the zero power experimental organic reactor are described in detail. (J.S.R.)

21788 METHOD OF NEUTRON DENSITY DISTRIBUTION MEASUREMENT IN MULTI-LAYER REACTOR CELLS. Adamski, L.; Jozefowicz, E. T.; Jozefowicz, K. (Inst. of Nuclear Research, Swierk, Poland). pp 32-6 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

A method of intra-cell neutron distribution measurement was developed for use in complicated reactor cells with multitube or multiplate fuel elements. A special type of detector is used which consists of a cylindrical spiral of copper wire which is placed in a hole drilled across the cell layers. The spiral is filled with a stratified rod consisting of pellets simulating all reactor cell materials (fuel, moderators, canning, etc.), thus minimizing the perturbing effects. After irradiation in the investigated lattice the activated spiral is cut in single coils of equal mass. The gamma activity of coils is measured using standard methods. The method described was developed for use in the ANNA zero-power reactor cells which are characterized by a number of relatively thin layers of fuel and moderator alternately spaced. The results obtained in different water–graphite- or graphite-moderated ANNA lattices are compared. The results of auxiliary experiments and a discussion of errors and corrections are given. The values of the thermal-neutron utilization factor are calculated on the basis of these results. (auth)

21789 DETERMINATION OF THE ρ^{28} PARAMETER IN MULTITUBE FUEL ELEMENTS USING CHROMATOGRAPHIC SEPARATION OF ^{239}Np. Jozefowicz, E. T. (Inst. of Nuclear Research, Swierk, Poland). pp 74-9 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The $^{28}\rho$ parameter was determined in the ANNA zero-power reactor lattices at two lattice pitches of 14.0 and 19.8 cm. The moderator was either graphite or water and graphite. The detectors were pellets of the same composition as the fuel material (38.5% UO_2 in Al). The method involved two irradiations, one in the lattice under study and the other in a pure thermal-neutron flux. The irradiations were normalized by means of auxiliary dysprosium foils. The neutron absorption rate in ^{238}U was determined by ^{239}Np activity, which was separated from the uranium and fission products by a method based on reversed phase partition chromatography with thenoyltrifluoroacetone solution as the stationary phase and neptunium in its 4^+ oxidation state. The remaining impurities were eliminated by an analysis of the decay curve. The dysprosium and neptunium activities were integrally gamma counted. The results for $^{28}\rho$ changed from about 1.3 in the relatively well-moderated lattices with water to 5.8 in the highly undermoderated lattices without water. Changes from tube to tube were also observed. (auth)

21790 SPECTRAL ANALYSIS OF FAST NEUTRONS IN ASSEMBLIES 42 AND 43 OF ZPR III BY MEANS OF NUCLEAR EMULSIONS. Beets, C. (Commissariat a l'Energie Atomique, Cadarache, France); Colle, P.; Deckers, H.; de Leeuw-Gierts, G.; de Leeuw, S.; Roberts, J. H.; Behkami, A. pp 115-23 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

Fast-neutron spectra were determined by means of nuclear emulsions irradiated at integrated fluxes of between 10^7 and 10^{10} neutrons/cm^2 in assemblies 42 and 43 of the zero power reactor ZPR III. Ilford L4 emulsion was used in both assemblies to observe the distributions of recoil-proton track lengths, and the neutron spectra are expressed in terms of two to three basic components. Two independently measured proton energy distributions in the range 580 keV to 3 MeV for assembly 42 were found to be in good agreement. The results also agree satisfactorily with the theoretical spectrum of MacVean et al. In assembly 43 Gevaert 307 fine-grain emulsion loaded with ^6Li was used to measure recoil-proton track lengths and the total track lengths from the $^6Li(n,t)\,^4He$ reaction. The recoil-proton analysis compares well with the theoretical spectrum between 180 and 825 keV, with a tendency for the experimental spectrum to be harder. The tracks from the $^6Li(n,t)\,^4He$ reaction were analysed in the range below E = 200 keV, and the experimental distribution compared with results calculated from the theoretical spectrum using parameters evaluated by Bluet et al. The conclusion is that a softer theoretical spectrum would be in better accord with the experimental results. (auth)

21791 EXPERIMENTAL FLUX MEASUREMENTS IN THE DOUNREAY FAST REACTOR AND THEIR COMPARISON WITH THEORY. Edwards, A. G.; Atkinson, H. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 140-51 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories

(C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The Dounreay fast reactor is now operating as a fast-flux materials testing reactor at a thermal power of 60 MW and a centre flux of 2.5×10^{15} neutrons cm^2/sec. The values of gamma and neutron fluxes throughout the core and inner breeder are required with greater precision for predicting rig conditions than they would be for operating the reactor as a power plant. Experimental data must be obtained with minimum reduction in reactor load factor. The techniques and apparatus which were adopted are described and attention is drawn to the changed emphasis since the original commissioning experiments. Reactor modification has altered the flux profiles and these are explored using a minimum of spectrum sensitive materials and concentrating on speed and reliability of experimentation. Recently measured reaction-rate distributions are quoted for different rod configurations. A substantial attempt was made to reproduce this information by calculation and the progress of this work is described. It is concluded that none of the present data sets is really adequate for calculations on DFR to the degree of accuracy required. (auth)

21792 MEASUREMENT OF FAST NEUTRON SPECTRA IN THE ZERO POWER FAST REACTOR ZEBRA. Pattenden, S. K. I.; Stevenson, J. M. (Atomic Energy Establishment, Winfrith, Eng.). pp 193-200 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The techniques used to measure neutron spectra in the ZEBRA fast reactor are described. The high-energy range (0.5 to 5 MeV) is covered by a $^6Li(n,\alpha)$ solid-state detector. Hydrogen-filled proportional counters are used for the energy range 60 to 800 keV. Results are presented for three ZEBRA assemblies, and in two cases the ^6Li results are compared with data covering a similar energy range obtained by Benjamin and Nicholls using photographic plate detectors. A comparison is made between the measured spectra and those calculated using the FD 2 cross section set of Smith et al. (auth)

21793 STATISTICAL ANALYSIS OF ESTIMATES FOR THE POWER SPECTRAL DENSITY IN NEUTRON-MULTIPLYING SYSTEMS. McGrath, Elgie James. Seattle, Univ. of Washington, 1966. 150p.

Thesis.

Formal development of the theory for harmonic analysis of neutron multiplying systems is carried out completely in the frequency domain. From basic probability theory, and an assumed reactor or model, the entire problem is expressed as the Fokker-Planck equation in terms of the characteristic function, thus enabling the required moments to be obtained. Second moment calculations include investigation into the bias in estimates of the power spectral density arising from the existence of finite record lengths. It is seen that for even very long records large biases can result, particularly at the lower frequencies. Other contributions to the bias such as the infinite delay time approximation, non-stationarities, and filters are included. Variance analysis for estimates of the power spectral density investigates fourth moments of neutrons, delayed neutron precursors, and Fourier coefficients, revealing that the extraneous neutron source plays a particularly important role. For reactors with very large sources, the Fourier coefficients are seen to be Gaussian. For systems with small sources, variance in estimates of the power spectral density can become very large, and even the classical smoothed estimate is not consistent. A recently suggested cross-correlation method of harmonic analysis is compared on a statistical basis to the usual power spectral density estimate, and from an equivalent standpoint is shown to have the larger normalized standard deviation. Finally, power spectral densities that exhibit anomalous structure due to feedback or signal content are investigated using a linearized theory derivable from the appropriate Fokker-Planck equation. It is shown by example that distinct differences can exist in both the qualitative and quantitative aspects of the spectra when compared to the usual approach that employs the square modulus of the reactor transfer function. (Dissertation Abstr.)

21794 TWO-DETECTOR CROSS CORRELATION EXPERIMENTS IN THE FAST-THERMAL ARGONAUT REACTOR STARK. Seifritz, W.; Stegemann, D.; Vaeth, W. (Kernforschungszentrum, Karlsruhe, Ger.). 28p. (CONF-660206-21). DTIE. Gmelin, AED-CONF-66-014-14.

From Symposium on Neutron Noise, Waves, and Pulse Propagation, Gainesville, Fla.

Autopower and crosspower spectral density measurements have been performed in the externally unperturbed Fast-Thermal Argonaut Reactor STARK, using the frequency analysis of noise technique. Theoretical considerations showed the advantage of two-detector crosscorrelation experiments over single-detector autocorrelation experiments, because the contribution of uncorrelated noise is eliminated in the output-signal. This was verified experimentally. The advantage of the crosscorrelation method is particularly important, if only low detector efficiency is available, as is the case in fast reactors. A detailed experimental program has been performed to show the extent to which the autopower and crosspower technique is applicable. Different detectors have been placed into the fast core region and into the thermal core region of STARK. In order to obtain reliable results from the data for the prompt neutron decay constant, reactivity, and absolute reactor power it was found that for the single-detector experiment the ratio of correlated to uncorrelated noise must be at least 2, whereas for the two-detector crosscorrelation experiment reliable results have been found with values of the ratio down to 0.1. The necessary time for sampling and analysis increases with decreasing values of the ratio. This has been theoretically confirmed by calculation of the relative standard deviation in crosspower spectral density experiments. The calculated deviations have also been checked experimentally. An optical correlation demonstrator is described which can be used to show the degree of correlation in a quick and simple manner. (auth)

21795 PROCESS FOR CONTROLLING THERMAL NEUTRON CONCENTRATION IN AN IRRADIATED SYSTEM. Harmer, David E.; Borst, Lyle B. (to Dow Chemical Co.). U. S. Patent 3,280,329. Oct. 18, 1966. Filed Aug. 8, 1962.

A process is presented which allows control of the thermal neutron environment of a reactor when only γ radiation is desired. The procedure consists of dispersing an absorber material in the system, which is to be irradiated, so that the thermal neutrons are absorbed while the γ rays are allowed to pass through. (M.L.S.)

Reactor Components, Fuels and Accessories

Refer also to abstracts 20489, 20495, and 21758.

21796 (AEEW-M-697) NOVA: A COMPUTER CODE FOR TWO-DIMENSIONAL BURNUP CALCULATIONS. Clarke, W. G. (Atomic Energy Establishment, Winfrith (England)). Mar. 1966. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

NOVA is a FORTRAN code which calculates the spatial distribution of burnup in a reactor in one or two dimensions. It operates in four or five groups and takes as input data the results from a set of point burnup calculations in the reactor materials, giving as output the reactivity, power and burnup distributions at intervals throughout the life of the reactor. (auth)

21797 (AEEW-R-496) OTTER 3: A SINGLE CHANNEL, AXIAL BURNUP CODE. Hopkins, D. R. (Atomic Energy Establishment, Winfrith (England)). Nov. 1966. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 3s.

OTTER 3 is a single channel, axial burnup code, written in FORTRAN for the KDF 9 computer, and suitable for studying fuel management schemes of the continuous charge/discharge type. A general fuel shuffling scheme is allowed, and both unidirectional and bidirectional fuel feed can be studied. A 2-group neutron diffusion code is incorporated, the flux equations being solved by the forward elimination–backward substitution technique for the inner problem and a source iteration technique accelerated by Chebyshev extrapolation, for the outer problem. (auth)

21798 (BNWL-330) TRUNK: FORTRAN PROGRAM FOR THE BUCKLING OF TRUNCATED SPHERES. Czerniejewski, F. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1967. Contract AT(45-1)-1830. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Approximations and methods incorporated into the code for use in finding the buckling for a specified truncated fuel sphere and converting it to an equivalent full sphere are presented. (J.R.D.)

21799 (COO-1624-6) NUCLEAR RADIATION EFFECTS ON SILICON P–N JUNCTIONS. Progress Report. Goben, Charles A. (Missouri Univ., Rolla. Electronics Research Center). Feb. 17, 1967. Contract AT(11-1)-1624. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Equipment has been purchased and integrated to form the sophisticated electronic measuring apparatus required for studying nuclear radiation effects in silicon p-n junctions. A technique for separating the collector multiplication term into its two components collector efficiency and collector multiplication factor has been developed. In the high current level regime, during and after the onset of conductivity modulation, a bulk recombination phenomenon in the neutral base region is predicted and observed to

account for the degradation of transistor current gain. A study is being made of the behavior of the inverse current gain under neutron bombardment in an attempt to learn more about the anomalous behavior. Work is in process in examining the anomalous annealing effect of the neutron-induced recombination center in the emitter-base space charge region, the collector-base space charge region and the neutral region through isochronal annealing techniques. A quasi-tunneling model is being investigated to determine if this model will predict the observed changes induced by neutron bombardment in the p-n junction current component at low and intermediate current levels. (auth)

21800 (EUR-3264.f) ETUDE THEORIQUE ET EXPERIMENTALE D'UN NOUVEAU PROCEDE DE PRECONTRAINTE. (Theoretical and Experimental Studies of a New Prestress Proceeding). (Compagnie d'Ingenieurs et Techniciens d'Etudes, Paris (France)). 1967. 56p. (In French). Dep. mn.

A new prestress procedure, called global prestressing, applicable to nuclear reactor caissons is presented. The results of the first researches carried out by CITE are given. The studies undertaken by CITE, the purpose of which was the elaboration of a preliminary project for the utilization of the proceeding to a reactor caisson of the same type as that under execution, i.e., that of the EDF INCA reactor, are described. The studies were carried out in two stages: (1) a general method of calculation worked out by using the "Theory of Plates and Shells" by Timoshenko in strength of materials; (2) calculation of the internal stresses and strains by using a two-dimensional method of thermoelasticity, the principle of which is briefly exposed. (auth)

21801 (GA-5846(Rev.)) TUNGSTEN NUCLEAR ROCKET CRITICAL FACILITY: DESCRIPTION AND HAZARDS ANALYSIS. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Feb. 18, 1965. 179p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An outline of the experimental program to be conducted at the facility is presented in which it is noted that no unusual or exceptionally hazardous experiments are planned. The core arrangement is such that addition or removal of single fuel elements does not involve inherently large reactivity changes. The same may be said of the poison inventory used to hold down excess reactivity. Descriptions are included concerning the facilities and the site. Safety aspects of the assembly are outlined and information is included on nuclear calculations for the facility, facility organization and procedures, and analyses of postulated accidents. (J.R.D.)

21802 (GA-7460) BASIS OF PRESTRESSED CONCRETE PRESSURE VESSEL DESIGN. Burrow, R. E. D. (Taylor Woodrow Construction Ltd., Southall (England)). July 1965. Contract AT(04-3)-633. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For General Atomic, San Diego, Calif.

The general criteria that have been adopted in preparing the tender design for the Dungeness "B" prestressed concrete pressure vessel are given in the form of a design code. Comments are made on these criteria. (P.C.H.)

21803 (STI-DOC-10/70) ORGANIC LIQUIDS AS REACTOR COOLANTS AND MODERATORS. Technical Reports Series No. 70. Report of a Panel held in Vienna, 9-13 May 1966. (International Atomic Energy Agency, Vienna (Austria)). Jan. 1967. 157p. (CONF-660553). IAEA: $3.50; S 91,-; £ 1.4.9; F Fr 17,20; DM 14,-.

The programs in Canada, France, Hungary, India, Spain, the United States of America and Euratom are described and topical summaries, based on the individual technical papers, of the technical sessions are included. The sessions dealt with: organic compounds and measurement of their physical properties; stability of organic compounds; heat transfer and fouling; reclamation and purification; and analysis and analytical techniques. The summaries are in English; five of the status reports are in English and two in French. Abstracts of the individual technical papers on which the summaries are based are provided in the original language and in English if this is not the original language. (auth)

21804 POSSIBLE APPLICATION OF "CALCULATED COSTS" METHOD TO CHOICE OF FAST REACTOR CHARACTERISTICS. Lytkin, V. B.; Troyanov, M. F.; Novozhilov, A. I. At. Energ. (USSR), 21: 360-3(Nov. 1966). (In Russian).

Methods of using cost formulas for economic analysis of the fuel cycle of fast Pu reactors are described. Formulas to account for the accumulation of the materials produced in the active zone and the shield fuel cycles are proposed. The results of the calculation, in which the dependence of the fuel component cost on the thermal intensity and depression of the active zone of a 1000 MW(t) electric output reactor, are reported. (tr-auth)

21805 FUEL ELEMENT BURN-UP DETERMINATION WITH SEMICONDUCTOR GERMANIUM γ SPECTROMETER. Groshev, L. V.; Demidov, A. M.; Kotel'nikov, G. A.; Miller, O. A. At. Energ. (USSR), 21: 412-15(Nov. 1966). (In Russian).

The possibility of using Ge detectors for measurement of the γ spectra in burn-up determinations was investigated. The spectra obtained with the Ge detectors are given. The results show that these detectors can be used in the non-destructive determination of burn-up. The energies and intensities of the γ lines observed are tabulated. (J.S.R.)

21806 UO_2/SHEATH HEAT TRANSFER DURING IRRADIATION. Bain, A. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Appl., 3: 240-4(Apr. 1967).

Variables studied were diametral clearance, heat-transfer medium, duration of irradiation, and power rating. After irradiation, fractured and polished cross sections and β autoradiographs were examined to determine the temperature distribution in the UO_2. The heat-transfer coefficient h increases with increasing power per unit length. For a specified power, h increased with lower initial clearances. The use of He instead of Ar increased h especially with large clearances, but by a factor much less than the ratio of the thermal conductivities of the gases. Values of h varied widely with lead-bonding; in some positions, h was very large, whereas in others its values were less than for the Ar-filled elements. Metallographic examination showed that the lead had moved from some areas of the interface, leaving gaps with poor heat transfer. In the loop elements the grain-growth pattern indicated that some of the heat passed through the lead that had flowed between the pellets. Elements evacuated just before final sealing had values of h equal to or higher than those for Ar-filled elements. This is tentatively attributed to the release of natural gases (mainly hydrogen) from the UO_2 pellets during irradiation, as observed in auxiliary experiments. (auth)

21807 WAVE-METHOD SOLUTION FOR SINGLE-GROUP CRITICALITY PROBLEMS. Troyanskii, V. B.; Smelyanskaya, A. V. pp 78-84 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A general solution for the dimensionless radius-vector is obtained by breaking down the single-group, kinetic equation of a multiplying medium into a Fourier integral. An expression for the critical size is obtained for plane, spherical and cylindrical geometries. The system of equations can also be extended to a reflector. Expressions are obtained for the critical size of a sphere, an infinite cylinder, a finite cylinder, and a plane reactor with a reflector as a function of the material properties of the medium, the thickness of the medium, and the thickness of the reflector. (TTT)

21808 EXPERIMENTAL STUDY OF THE RIGIDITY OF PERFORATED PLATES. Harrop, J.; Abdul-Wahab, H. M. S. (Univ. of Sheffield, Eng.). Nucl. Eng. Design, 4: 480-9(Dec. 1966).

A study of the effective rigidity of perforated flat plates is described, which forms part of a general study of perforated plates with particular reference to concrete reactor pressure vessels. Consideration is given to circular perforations on an equilateral triangular grid pattern, the perforation being unstiffened. The experimental results are compared with previous theories and with a new analytical approach based on a thick cylinder analogy. (auth)

21809 MEASUREMENTS OF NEUTRON IMPORTANCE IN A FAST REACTOR TEST REGION CONTAINING POLYETHYLENE-MODERATED TEST CELLS. Tuttle, R. J. (Atomics International, Canoga Park, Calif.). pp 211-19 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

The variation of neutron importance with energy and position has been studied in a multi-region critical assembly using a fast reactor test region perturbed at the centre by polyethylene-moderated test cells having different thicknesses. Measurements were made in a standard core having no polyethylene, and in test cells with 0.125, 0.250, and 0.500 in. thick polyethylene, using Po-Be, Po-^{11}B, Po-F and Po-^{7}Li neutron sources. Two types of measurements were performed: central importance measurements and importance traverses. For the central importance measurements, a reactivity oscillator technique was used to measure the apparent reactivity of a neutron source at the centre of the reactor. Inactive dummies, each matching a source, except that the polonium was omitted, were used to cancel the material reactivity effect. The small residual reactivity difference was determined by making measurements at low and high powers. To measure the variation of importance with position, a source was moved through the reactor at low power to emphasize the apparent

reactivity of the source neutrons, and at a high power to emphasize the true reactivity of the source materials. A computer program for dynamic reactivity measurements was used to extract the neutron importance from these two measurements. Comparison of experimental and calculated values indicates fair agreement for the standard core and the two thinner blankets; calculated importance in the 0.500 in. blanket is too high. (auth)

21810 ABSOLUTE MEASUREMENT OF FISSION, ACTIVATION AND NEUTRON-EMISSION RATES. Redman, W. C. (Argonne National Lab., Ill.). pp 303-10 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power, Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

In both basic reactor physics measurements and applied reactor design studies, absolute measurements are either necessary or advantageous. Specific examples drawn from the programme at the Argonne National Laboratory are given in a survey covering the application of established techniques, and unique aspects encountered in their use for reactor-related problems. For most requirements, absolute fission and activation rates are obtained from measurements on irradiated foils. Both single-channel counting and coincidence methods currently used are described, and the importance of intercomparison experiments is emphasized. Calibration of neutron detectors by coincidence counting is also outlined. The survey concludes with a selection of specific examples of the use of absolute measurements in achieving reactor development objectives. (auth)

21811 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Johnson, Frank Geoffrey; Crook, Clifford; Leatham, Harold (to United Kingdom Atomic Energy Authority). British Patent 1,062,471. Mar. 22, 1967. Filed Feb. 28, 1963.

A design is given for water-tight seals for end caps for vertical reactor access tubes. These seals, or end caps, form a flush surface with the spaces between the ends of the vertical tubes and are secured into these flush surfaces. (M.L.S.)

21812 IMPROVEMENTS IN OR RELATING TO MODERATOR CORES FOR NUCLEAR REACTORS. Warner, Philip Cloudesley (to United Power Co. Ltd.). British Patent 1,059,775. Feb. 22, 1967. Filed Nov. 13, 1964.

A design for a solid moderator core structure is given. It consists of a number of closely spaced adjacent columns of prismatic blocks with interlocking keyways which are arranged so as to minimize any voidage that may occur in the core structure. (M.L.S.)

21813 FUEL ELEMENT FOR NUCLEAR REACTORS. (to Gesellschaft fuer Kernforschung mbH.). British Patent 1,059,215. Feb. 15, 1967. Priority date Aug. 17, 1963, Germany.

A design for a fuel element for fast reactors is given. The design is comprised of longitudinal fins which serve as spacers. These are shaped as hooks which are open in the axial direction, allowing them to engage hooks on adjacent fins. This shaping of fins allows axial elongation while restricting radial movement. This also eliminates use of braces in coolant channels. (M.L.S.)

21814 NUCLEAR REACTOR FUEL. (to Atomic Energy of Canada Ltd.). British Patent 1,062,875. Mar. 22, 1967. Priority date Oct. 10, 1962, Canada.

A process is given for treating previously shaped, sintered, and densified masses of hyperstoichiometric fissile dioxide material to improve thermal conductivity properties. A design is presented which comprises a sintered and densified dioxide of fissile material, or mixture of materials, part of which has a hyperstoichiometric-defect crystalline composition. A method for attaining improved reactor performance by using it to heat-treat the fuel particles is described. (M.L.S.)

21815 LATCH DEVICE FOR NUCLEAR FUEL. (to Atomic Energy of Canada Ltd.). British Patent 1,059,195. Feb. 15, 1967. Priority date Sept. 30, 1964, United States.

A design is presented for a latch mechanism for fuel-rod-assemblies which are joined end-to-end. (M.L.S.)

21816 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Macfall, Derek; Butterfield, Colin Edgar; Butterfield, Roy Stuart (to United Kingdom Atomic Energy Authority). British Patent 1,052,777. Dec. 30, 1966. Filed Dec. 10, 1964.

A description is given of a fuel rod cluster which is supported and braced at the lower end by a structural sleeve. The fuel rods are moveable with respect to each other or with respect to other longitudinal braces that may be used. The central member of the cluster is a hollow tube which serves as a lifting device for the cluster. Specifications for this lifting device are also given. (M.S.)

21817 HEATING ELEMENT ASSEMBLIES. Bell, Douglas Irving (to United Kingdom Atomic Energy Authority). British Patent 1,051,162. Dec. 14, 1966. Filed May 31, 1963.

A design is given for a fuel element assembly of longitudinal elements which are positioned by spacers. The assembly may vary in geometric shape. Central to the design is the spacer which contacts the assembly canning wall. The design of this spacer is covered in detail. (M.L.S.)

21818 ELEMENTS OF FISSILE MATERIALS CONTAINING A BURNABLE NEUTRON POISON. (to Reactor Centrum Nederland). British Patent 1,053,598. Jan. 4, 1967. Priority date Aug. 28, 1964, Netherlands.

A design is given for a fuel element containing burnable poisons. Basic to the fuel element is the use of fissile oxides. Fissile bromides, which are stable at high temperatures, are included as burnable poison. Both the design for the fuel element and the manufacturing process for the fuels are given. (M.L.S.)

21819 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Gittus, John Henry (to United Kingdom Atomic Energy Authority). British Patent 1,054,118. Jan. 4, 1967. Filed Nov. 19, 1962.

A process for prevention of diffusion of Pu through the cladding of a canned fuel element is given. A material which forms an intermetallic compound with the Pu, thereby acting as a barrier to diffusion, is incorporated into the cladding material. (M.L.S.)

21820 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL. Snowdon, Paul; Gittus, John Henry (to United Kingdom Atomic Energy Authority). British Patent 1,054,116. Jan. 4, 1967. Filed Oct. 23, 1962.

A process for the manufacture of fuel material cermets is presented. The fissile ceramic material is dispersed in a continuous metal matrix. A detailed procedure for handling the materials is given. (M.L.S.)

21821 DETECTION OF LIQUID BOILING IN A NUCLEAR REACTOR. Ledwidge, Thomas Joseph (to United Kingdom Atomic Authority). British Patent 1,052,239. Dec. 21, 1966. Filed Oct. 15, 1962.

A design is given for a nucleate boiling monitor to be used in liquid-cooled reactors. A sound guide, which penetrates the containment vessel and is embedded in the cooling liquid, is coupled to an electro-acoustic transducer and a recorder. Nucleate boiling is then detected from the sonic wave spectrum. (M.L.S.)

GENERAL

21822 (BNL–989) ENERGY CONVERSION BY THE PHOTOSYNTHETIC APPARATUS. Brookhaven Symposia in Biology Number 19. Report of Symposium held at Upton, June 6–9, 1966. (Brookhaven National Lab., Upton, N. Y.). Jan. 1967. Contract AT(30-2)-Gen-16. 522p. (CONF-660651). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Forty papers discuss the latest concepts of primary photochemical processes by which light is converted into chemical energy by algae, higher plants, and photosynthetic bacteria. Author and subject indexes are included. (800 references.) (C.H.)

21823 (CONF-660511) INTERNATIONAL SYMPOSIUM ON DEVELOPMENTS IN IRRADIATION CAPSULE TECHNOLOGY HELD AT PLEASANTON, CALIFORNIA, MAY 3–5, 1966. Hoffman, Donna R. (ed.) (Division of Reactor Development and Technology (AEC), Washington, D. C.). Mar. 1967. 932p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A total of 54 papers were presented at the symposium. Separate abstracts were prepared for 43 of these papers. Ten of the papers were previously abstracted in NSA appearing in Vol. 20 as abstract numbers 23770, 26515, 28754, 31785, 32862, 33604, 33605, 33940, 34890, and 43996. The paper for which no abstract was prepared is concerned with capsule design for fission recoil and thermocouple studies. (J.R.D.)

For abstracts of individual papers see: 19792–19808, 19837–19839, 19865–19869, 19984, 20533–20538, 20591–20595, 21629, and 21758–21762.

21824 (COO–1140-141) AN APPARATUS FOR COMBINED WEIGHT LOSS AND TORSION EFFUSION STUDIES, AND THE VAPOR PRESSURES OVER BORON SULFIDE. Werner, Donald W. (Kansas State Univ., Manhattan. Dept. of Chemistry). Dec. 8, 1965. Contract AT(11-1)-1140. 79p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

An apparatus was constructed capable of providing continuous and simultaneous weight loss and torsion effusion vapor pressures. The torsion pressures can be combined with the weight loss values to provide estimates of the molecular weights of the effusing vapor. The vapor pressure of solid zinc has been measured in the 290 to 330°C range and the results of this study used to evaluate the performance of the apparatus. Boron sulfide was prepared, analyzed, and the vapor pressure over its condensed phase measured in the temperature range of 512 to 591°C and the pressure range of 4×10^{-4} to 7×10^{-3} Torr. Three distinct processes were found to occur in this range. (auth)

21825 (EUR–3127.e) ELEMENTS OF A THIRD-PARTY LIABILITY INSURANCE CONTRACT FOR OPERATORS OF FIXED NUCLEAR INSTALLATIONS. Euratom Skeleton Third-Party Liability Policy in Respect of Installations. (European Atomic Energy Community). Aug. 12, 1966. 20p. Dep. mn.

The Euratom skeleton insurance policy is the result of cooperation between the Euratom Commission and the nuclear insurers, nuclear industry organizations, and electricity producers in the Community. It contains the elements of a nuclear third-party liability insurance contract. In view of the increasing unification of the nuclear industry in the Community, a standardization of the main clauses in this branch of insurance is recommendable. The skeleton policy is based on the provisions concerning liability in the Convention on Third-Party Liability in the Field of Nuclear Energy dated 29 July 1960 (Paris Convention) and the Supplementary Convention dated 31 January 1963 (Brussels Convention). (auth)

21826 (IDO–17130) DYNAMICS OF WORK GROUP BEHAVIOR. Nertney, R. J. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Dec. 1965. Contract AT(10-1)-205. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Organizational behavior of personnel in several monitored areas is discussed. The following phenomena are reported: Large performance improvement in any area where formal control is established; times of two months to one year on response to control were observed in connection with control systems which are integrated into line organization; relaxation times of the order of two months were observed on work groups going out of control; large prompt reactions as well as delayed reactions were observed in relatively large populations in a situation involving a simple personnel change; and organizational response to a "Madison Avenue" type program is discussed. (auth)

21827 (KAPL-P–3314) SCAN-1, A GENERAL DATA PROCESSING SYSTEM. Mueller, Gerhard O. (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 26, 1967. Contract W-31-109-eng-52. 10p. (CONF-670406–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From General Electric Systems Engineering Techniques Symposium, Daytona Beach, Fla.

SCAN-1 a data processing system being written for the CDC-6600 computer is described. The main purpose of the program will be for reduction of experimental data. The data will then in many cases, be used as input to other programs. (B.G.D.)

21828 (LA–3638) PURIFICATION AND PROPERTIES OF RIBONUCLEIC ACID POLYMERASE FROM ESCHERICHIA COLI. Ratliff, Robert L.; Smith, David A.; Trujillo, Theodore T. (Los Alamos Scientific Lab., N. Mex.). Dec. 1966. Contract W-7405-eng-36. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A procedure for purification of RNA polymerase from Escherichia coli is described. This method allows processing of several times as many cells at once as do previous procedures. Investigations of contaminating enzyme activities and attempts to further purify the enzyme reveal that it is essentially a homogeneous protein. The amino acid composition of the enzyme was determined. The purified enzyme has an $S_{20,w}$ value of 24.5 and a molecular weight of about 1.0×10^6. In 0.5M KCl, the enzyme sediments about half as fast as in low ionic-strength buffers. (auth)

21829 (NYO–3401-3) ENERGY TRANSFER IN CHEMICAL AND BIOLOGICAL SYSTEMS. Progress Report, March 1966–February 1967. Lee, John (New England Inst. for Medical Research, Ridgefield, Conn.). Contract AT(30-1)-3401. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The mechanism of chemiluminescence of luminol in frozen solutions of dimethylsulfoxide is by reaction in eutectic pools of water-dimethylsulfoxide. The enzyme was partially purified from the luminous bacteria, Photobacterium fischeri. Preliminary studies of the insoluble system from Gonyaulax polyedra are also presented. Fluorescence excitation spectra of quinine, rhodamine B, and fluorescein are compared, and it is concluded that quinine is not a suitable quantum counter for wavelengths <270 mμ. A new instrument for measurement of phosphorescence lifetimes is described. (auth)

21830 (ORNL-TM–1762) SUBROUTINE RKLDEQ FOR THE INTEGRATION OF FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS ON THE IBM 360/75. Nestor, C. W. Jr. (Oak Ridge National Lab., Tenn.). Mar. 10, 1967. Contract W-7405-eng-26. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The FORTRAN subroutine RKLDEQ for the integration of first order ordinary differential equations using the Runge-Kutta-Gill method has been adapted for use on the IBM 360/75 computer. A description of the use of this subroutine and the results of some test calculations are presented. For the equations and step sizes used in this study, the observed cumulative truncation errors were proportional to the fourth power of the step size, in agreement with the theoretical behavior of a fourth-order method. Round off errors were not observed for any step size. Since this subroutine is used in an unconventional way with the calculation of the derivatives being done in the calling program, a sample program is displayed in the test and must be carefully studied if the subroutine is to be used correctly. Familiarity with Gill's fourth-order Runge-Kutta method is also desirable. (auth)

21831 (ORNL-TM–1798) MULTIPLE FACTOR ANALYSIS. Durfee, R. C. (Oak Ridge National Lab., Tenn.). Mar. 10, 1967. Contract W-7405-eng-26. 93p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The purpose of factor analysis is to identify the dimensions or factors by which a variety of phenomena within a domain are related. Factorial methods were originally developed for the purpose of identifying the principal dimensions or categories of mentality; but the methods are general, so that they have been found useful for other psychological problems and in other sciences as well. Factor analysis is not restricted by assumptions regarding the nature of the factors, whether they be physiological or social, elemental or complex, correlated or uncorrelated. Thus, three programs were written which factor analyze a set of measurements in order that the underlying factors which relate the measurements may be identified. (auth)

21832 (SC-CR–66-2053) ANALYSIS OF EMBEDDED SENSOR TECHNIQUES FOR AUTOMATIC CHECKOUT SYSTEM. Final Report. Pressman, G. L. (Stanford Research Inst., Menlo Park, Calif.). Apr. 1966. Contract AT(04-3)-115. 148p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Sandia Corp., Albuquerque, N. Mex.

The results of detailed analysis of several techniques for in-

place sensors are summarized. A preliminary analysis permits the list of feasible techniques to be reduced to four principal areas: magnetic-core sensors, microcircuit techniques, electron-coupling techniques, and electro-optic and piezoelectric sensors. Specific sensor configurations in each of the above categories were analyzed and evaluated. The results of the evaluations are presented and the description and analysis of the representative sensors are included in a series of appendices. (auth)

21833 (SC-CR-67-2551) TELTAC: A TELETYPE TAPE-TO-CARD CONVERSION PROGRAM. PART I. DESCRIPTION AND FLOW CHARTS. Vandevender, Sharla (Dikewood Corp., Albuquerque, N. Mex.). Mar. 10, 1967. Contract AT(29-1)-789. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Sandia Corp., Albuquerque, N. Mex.

An OSAS-A program for the CDC-160A computer for processing Teletype paper tapes is described. The program, called TELTAC (TELetype TApe to Cards), is presented in flow chart form, and is segmented into a main routine and 8 subroutines. Each segment is adequately described. TELTAC accepts as an input a Teletype produced 8-level paper tape and produces as output a punched card deck, on a one-line-per card basis. (auth)

21834 (SC-DR-66-2715) THE PENETROMETER PROJECT. Trapp, D. L.; May, J. M.; Owens, J. K. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Penetrometer Project was undertaken to help establish the relationship between the bearing strength of soil-like materials and the deceleration of projectiles in these materials after impacts at velocities below 1500 feet per second. The penetrator, the instrumentation system, the targets, and the test facility which were developed for the project are described. The test operations are summarized, and typical unanalyzed test data are shown. (auth)

21835 (SC-R-67-1045) FIELD CALIBRATED SIMULATION. Swain, Alan D. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method called field calibrated simulation is suggested as one way of economically and expeditiously extending the results of large-scale field experimentation while maintaining necessary experimental control. In essence, the method consists of using field experimentation to calibrate the results of real-time and fast-time simulation. The method is described, with emphasis on real-time simulation, and some recent proposed applications are discussed. (auth)

21836 (SC-RR-67-53) COMPUTING SOUND RAY PATHS IN THE PRESENCE OF WIND. Thompson, R. J. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A FORTRAN 63 program for computing sound ray paths in the presence of winds is discussed. A listing of the program is included. The program also computes for each ray a quantity which indicates how the pressure at the point where the ray strikes the ground is affected by meteorological conditions. A discussion of how this quantity is defined and computed is included. (auth)

21837 (SC-RR-67-65) THE RANDOM NUMBER GENERATORS FOR THE SANDIA 3600 AND THEIR STATISTICAL PROPERTIES. Bell, S.; Holdridge, D. B. (Sandia Corp., Albuquerque, N. Mex.). Mar. 1967. Contract AT(29-1)-789. 145p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The statistical properties of particular pseudo-random number sequences which are easily obtainable on the Control Data 3600 are recorded. (auth)

21838 (SC-RR-67-79) GERBER FORTRAN ROUTINES. Plomp, P. W. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. 43p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An instruction manual for programmers wishing to use the Gerber Series 1000 Automatic Drafting Machine via Fortran II programs is presented. The subroutines described in this manual supply the codes required to prepare control tapes for the Gerber. The document was divided into four sections. The first describes the machine characteristics and identifies the meaning of each code, the second portion describes the proper use of each of the subroutines, the third gives two sample programs, and the last gives a check list of the program flow. (auth)

21839 (SC-TM-67-74) MOTION OF A RIGID CYLINDER PRODUCED BY AN ACOUSTIC PULSE. Forrestal, Michael J.; Alzheimer, William E. (Sandia Corp., Albuquerque, N. Mex.). Mar. 1967. Contract AT(29-1)-789. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A rigid, circular cylinder immersed in an acoustic medium is subjected to a step pressure pulse. Formulas for the displacement, velocity, and acceleration of the cylinder are developed. These formulas contain only elementary functions and can easily be used as influence coefficient to determine, by means of Duhamel integrals, the response produced by an arbitrary pressure pulse. (auth)

21840 (STI-DOC-10/65) LIMITING STEPS IN ION UPTAKE BY PLANTS FROM SOIL. Technical Reports Series No. 65. Report of a Panel held in Vienna, November 22–26, 1965. (International Atomic Energy Agency, Vienna (Austria)). Sept. 1966. 162p. IAEA: $3.50; Austrian Schillings 91,–; £ 1.4.9; F Fr 17,20; DM 14,–.

Sixteen papers discuss various factors affecting ion uptake by plants from soil. The topics discussed include the kinetics of phosphate release from soil; thermodynamic and thermochemical measurements of ion exchange reactions in clays; the dielectric properties of montmorillonite at various water contents; the distribution of ions at surfaces; the role of root interception, mass flow, and diffusion in regulating the uptake of ions by plants from soil; the role of mass movement and ionic diffusion in ionic migration through soils; the effects of soil physical processes on ion uptake; the diffusion of P and K through soil to plant roots; limitations to ion uptake by plants; the amounts of nutrients contacted by roots; primary processes of ion absorption by cells of higher plants; active and passive processes in ion translocation across root tissue; ion uptake under field conditions; oxidation-reduction status of the rhizosphere of rice roots in submerged soils; the uptake of ions by plants from salt-affected soils; and limiting steps in ion uptake by plants from soil. (C.H.)

21841 (TID-23421) GAS CONTENT, SIZE, TEMPERATURE, AND VELOCITY EFFECTS ON CAVITATION INCEPTION. Internal Report No. 31. Hammitt, Frederick G.; Ericson, David M.; Robinson, M. John (Michigan Univ., Ann Arbor. Lab. for Fluid Flow and Heat Transport Phenomena). Aug. 1966. Contract AT (11-1)-3424. 60p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The results of a comprehensive investigation into the effects of several variables on cavitation inception, primarily in a venturi, are reported. These include total air content, venturi throat size and velocity with water as the test fluid. The effects of gas content, venturi throat size, surface roughness, velocity, and fluid temperature, with mercury as the test fluid are also examined. The data were correlated using a computerized least mean square regression analysis. A final correlation of all measured cavitation numbers with Reynolds number, based on venturi throat diameter and velocity, is also included. (auth)

21842 (UCRL-13284) CODE SKID 1: A STUDY OF THE FRICTION IGNITION OF A SPHERICAL OR HEMISPHERICAL SAMPLE OF EXPLOSIVE MATERIAL IN A SLIDING IMPACT "SKID" TEST. Weston, A. M. (Brobeck (William M.) and Associates, Berkeley, Calif.). Feb. 1967. Contract W-7405-eng-48. 96p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Univ. of California Lawrence Radiation Lab., Livermore.

The theory and operation of Code SKID 1, a Fortran II program that calculates the mechanical dynamic response and associated thermal response of a spherical or hemispherical sample of explosive that is dropped against a flat surface at an initial angle and velocity in a sliding impact "skid" test is described. A preliminary parametric study is also described to illustrate the nature of the skid test response and the potential use of the program in improving the understanding of experimental results. (auth)

21843 (UCRL-14564) OPTICAL ALIGNMENT USING A GAS LASER. Cast, John C.; Wasley, Richard J. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 16, 1965. Contract W-7405-eng-48. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The use of continuous-wave gas lasers to align optical and mechanical equipment is discussed. Two examples are given to illustrate the general approach. The first is a method aligning certain experiments using the reflected wire technique for measuring shock and free-surface velocities. The second method involves aligning a gun facility so that the sample is perpendicular to the center line of the gun barrel. (B.G.D.)

21844 (UCRL-16214) A WATER-COOLED WREDE-HARTECK GAUGE FITTING. Rony, Peter R. (California Univ., Berkeley. Lawrence Radiation Lab.). June 11, 1965. Contract W-7405-eng-48. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A Wrede-Harteck gage was constructed that differs in four important respects from previous ones: it is mounted separately from the pressure transducer, it is water-cooled, its effusion-hole diaphragm can be easily replaced, and it can be used with any differential micromanometer that has a small residual volume. (B.G.D.)

21845 (UCRL-50160) SIGNIFICANCE OF ELECTROSTATIC INTERACTIONS IN DETERMINING PROTEIN CONFORMATION. Bjorklund, Russell F. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 9, 1966. Contract W-7405-eng-48. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The significance of electrostatic interactions between charged amino-acid residues in determining and stabilizing protein conformation is assessed. To implement this, a code was constructed that generates large statistical samples of conformations of simplified models for reduced chymotrypsinogen, ribonuclease, and lysozyme. If electrostatic interactions play a significant role in determining the proper refolding of the reduced and denatured protein so as to restore it to the native state, then we might expect that conformations that bring the correct pairs of cysteine residues into close proximity would, on the average, have lower electrostatic potential energies than other conformations. This would result in a positive correlation between the electrostatic potential energy and the cysteine distances in the statistical samples mentioned above. In only one instance, the first S-S link of chymotrypsinogen with infinite Debye radius (ionic strength = 0), was there a statistically significant indication that electrostatic interactions would tend to favor proper refolding. Because of the approximations involved, these results do not completely rule out a significant role for electrostatic interactions in determining and stabilizing protein conformation. However, they make it seem unlikely that such interactions are essential for proper folding, at least for the three proteins tested. One possibility suggested by the paper, which could be tested experimentally, is that at low ionic strength, electrostatic interactions might actually hamper the correct repairing of cysteine residues during the renaturation of lysozyme. (auth)

21846 DETERMINATION OF THE PROFILE OF A SHOCK-WAVE FRONT. Klement'ev, V. M. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, Ser. Tekh. Nauk, No. 3, 154-6(1966). (In Russian).

It has been established before that it is possible to increase the frequency of an electromagnetic wave by reflecting it repeatedly from a moving plasma cluster, playing the role of the walls of a resonator. Instead of plasma clusters, shock waves may be used, however, the profile of the wave must be known, in order to choose the required conditions. Therefore, a method was developed for determining this profile at various distances from the source. The shock tube used consisted of a coaxial steel cylinder injector and a glass tube. The intensity of the light emitted by the diffraction cloud decreases with its distance from the screen. The pulse duration was about 400 μk/sec. The 300-μkF capacitance condenser battery was discharged at 4.5 kV. The velocity of the wave in neon gas was about 2×10^6 cm/sec at a pressure of 0.3 mm of Hg. (TTT)

21847 THE LONG-TIME ENERGY SUPPLY OF THE GERMAN FEDERAL REPUBLIC AND THE ROLE OF NUCLEAR ENERGY. Mandel, H. (Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen). Atomwirtschaft, 12: 44-52(Jan. 1967). (In German).

The primary energy consumption of the German Federal Republic is estimated up to the year 2000. The domestic fuel supply and the import needs are considered. The structure of the total primary energy supply is given. The role of electricity in supplying this total is estimated, and the fraction of the total that can be supplied by nuclear energy is evaluated. The problems that will be encountered in the introduction of nuclear energy are outlined. (J.S.R.)

21848 SPACE CRAFT SYSTEMS. Proceedings of the XVIth International Astronautical Congress, Athens, 1965. Lunc, Michal (ed.). New York, Gordon and Breach, 1966. 564p. (CONF-650985-(Vol.1)).

Twenty-six papers on various engineering aspects and applications of spacecraft systems are presented. (J.H.M.)

21849 PROPULSION AND RE-ENTRY. Proceedings of the XVIth International Astronautical Congress, Athens, 1965. Lunc, Michal (ed.). New York, Gordon and Breach, 1966. 439p. (CONF-650985-(Vol.5)).

Twenty-one papers on rocket propulsion and re-entry are presented. (J.H.M.)

21850 ASTRODYNAMICS. Proceedings of the XVIth International Astronautical Congress, Athens, 1965. Lunc, Michal (ed.). New York, Gordon and Breach, 1966. 461p. (CONF-650985-(Vol.6)).

Twenty-seven papers on various aspects of astrodynamics are presented. Some of the topics include information on orbits and motion of artificial satellites, lunar communications, time of flight, comet missions, and exploration of comets. (J.H.M.)

21851 LIFE IN SPACE CRAFT. Proceedings of the XVIth International Astronautical Congress, Athens, 1965. Lunc, Michal (ed.). New York, Gordon and Breach, 1966. 349p. (CONF-650985-(Vol.7)).

Thirty-one papers are presented which include information from various tests and studies related to life in spacecraft. (J.H.M.)

21852 ENERGY R AND D AND NATIONAL PROGRESS: FINDINGS AND CONCLUSIONS. Washington, D. C., Office of Science and Technology, [1966]. 23p. GPO $0.15.

The findings and conclusions of the Energy Study Group, appointed to study the most effective development and use of the total energy resources of the United States, are presented. Potential energy sources described are oil, gas, coal, uranium and thorium, and controlled nuclear fusion. The availability, costs, health hazards, and other aspects of each source of energy are considered. Current research and development in each of these energy fields is reviewed, and recommendations are made for future private and governmental research and development work. (L.C.L.)

21853 ENERGY R AND D AND NATIONAL PROGRESS. Prepared for the Interdepartmental Energy Study by the Energy Study Group under the Direction of Ali Bulent Cambel. Washington, D. C., Office of Science and Technology, [1966]. 472p. GPO $1.50.

In 1963 the Energy Study Group was appointed by the U.S. Government to determine the present state of development and utilization of our total energy resources, and to recommend how research and development in the energy field can best stimulate the rate and pattern of our national economic growth. The whole spectrum of science and technology necessary for future abundant, flexible, and economically sound sources of energy was studied. The major energy sources, including fossil fuels, nuclear, hydraulic, and thermal, are described. Conversion systems are discussed. The economics of research and development, both federally and privately sponsored, are detailed. Research and development is recommended which will encompass not only basic energy sources, but the conversion, transportation, and storage of energy, the socioeconomic considerations of energy development, and the environmental aspects of power production. (L.C.L.)